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"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH

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RESETTLEMENT OF POPULATIONS

IT is inevitable that some of the most pressing problems of the post-war world will centre around the question of redistribution of population, for this is not only at the root of matters of over-population and employment but concerns also the question of the place of minorities outside the national major consciousness in many areas. The problems will arise in Europe, in the tropical colonies, in South America, and in the great Dominions. While it is a mere truism to say that the globe still offers considerable areas of under-populated and scantily productive lands, it is obvious that the problem of shifting populations from one area to another involves far more cogent considerations than a mere study of numbers and population density.

The intricacies of the problem of redistributing populations are great and cannot be settled on a narrowly statistical basis Following on a mere trickle, mainly of adventurers and unwilling deportees in earlier centuries, the nineteenth century was a period of free and unregulated flow of population from Western Europe to the poorly populated regions of North America, Australia, New Zealand, etc., and to a less extent from Mediterranean Europe to South America. The outward flow was actuated partly by economic failure at home, partly by political unrest, and most of all, perhaps, by the brighter hopes of prosperity born of the growing need of the industrialized lands to increase their food imports.

The need for exotic raw materials as well as the hope of establishing new markets for manufactured goods led also to the establishment of sovereign claims to almost all parts of intertropical Africa and other areas in low latitudes. These areas, unlike the temperate lands, afforded little or no outlet for European settlers but raised many thorny problems in control and utilization. The number of Europeans engaged in directing the native cultivator and urging him by one means or another to increased output is small; but the means of controlling these tropical areas and their local inhabitants has fomented serious problems in the redistribution of population and unfortunate interference with tribal life and native culture, to an extent scarcely compatible with high standards of either equity or wisdom. In Africa, outside the tropics, the white man finds land within the margin of his demand for progressive settlement; but the margin is often a fine one and is liable to be transgressed. Both in North and South Africa, the European has to compete with established races admirably suited to the environment.

Racially, this new dominion of the tropics did not involve the destruction of aboriginal inhabitants—as in most expansions to temperate lands—but rather a desire for increased native population to meet labour demands. The large-scale migration was not merely a European exodus. Later, but in a steady flow, the dense agricultural populations of the East sought more productive homes as Indians moved to East Africa and Malaya, Chinese to Malaya, Burma and Pacific islands, and Japanese to Hawaii and North America.

Attempts in the nineteenth century and earlier to transfer people from high to low latitudes met with little success, and the failure of the experiments was attributed to unsuitable climatic conditions. There were, however, other factors at work; and even in temperate lands the suitability of the climate was not the sole factor in promoting success or apparent success. The twentieth century saw a checking of the growing outward flow of population from Europe, largely due to legislative decisions of various States which affected even more drastically the coloured races. These restrictions were based mainly on economic grounds, but biological and political expediencies were not overlooked. The danger of lowering the high standard of living by the introduction of cheap coloured labour was no doubt as powerful a motive as the inability of the State to absorb into national unity so many alien racial elements, in closing the doors of North America and the Commonwealth of Australia to other than 'white' races. The lodgement of many Italians in the Argentine, and Swiss and Germans in southern Brazil, was in the first case due to political affinity of the Latin outlooks, and the second to political expediency in the avoidance of unsympathetic majorities in more obviously suitable lands. The danger of Brazil's experiment with Japanese colonists is a glaring example of lack of vision in this respect.

The experience of several countries has at least made clear the complexity of the problem, but the expediency of organized migration was never more pressing than it will be in the near future. If it be left to the dictates of political rivalry untempered by an appreciation of the many issues involved, little or no success can be anticipated. There are many aspects of the problem besides the political one. The physical factors for successful settlement are so obvious that they tend to obscure subtler considerations. Surface relief, soil, water supply, routes and transport facilities are clearly of importance. Ways of living, types of houses, clothing and diet, habits in which people are strongly conservative, are largely bound up with climate; but climatic influences resolve themselves largely into the amount of insolation, a function rather of latitude than of climate, and degree of relative humidity. Then again, many of the failures, formerly attributed to the climatic factor, to colonize or even effectively to dominate intertropical areas have been shown to be due to diseases, especially insect-borne diseases, and in measure as the insects can be destroyed or kept at a distance the threat of diseases disappears.

Another and totally different factor arises from the existence or not of the colour bar, coupled with the desire to avoid hybrid races. This feeling differs widely among migrating peoples and is strongest in those with least pigmentation. Another biological factor is of primary importance. There can be no true colonization unless the birth-rate remains high in relation to the death-rate. If the latter increases and the former decreases, the experiment of transferring population is doomed to failure. This important factor is impossible to predict, and seems to vary not only in regard to racial stocks but also in relation to the actual density of population. Some elements in a population seem to show a lowering of fecundity as density increases. Each land and each racial stock have their optimum densities. This optimum density is determined also by economic factors: the standard of living falls in an area where subsistence farming is carried too far, even though it may be temporarily relieved by industrialization. A potent biological consideration is the competition by widely divergent races. The attempts at Japanese expansion which have occurred during the past forty years is the chief example. Virtually all important outlets have been closed to them, and none will probably be open after the defeat of Japan in the present War. Japanese aims, and to a less extent Chinese aims, involve racial rivalry rather than intertribal competition.

There are, of course, many other economic factors involved, such as location in determining proximity to markets, and the relation of aboriginal to introduced labour. While above and beyond these considerations is the political one, which is concerned with avoidance of the national disunity that arises from the growth of small groups of traditions, cultures and languages distinct from the majority, and the resultant weakening of national consciousness. Considerations such as these are all of importance in deciding the uprooting and replanting of population. Varying weight must be given to the different considerations in every case. Within Europe, where the climatic factor may be less important, the economic and cultural ones are of greater weight. Acre for acre can never denote an equitable exchange, and no measure of even comparative stability can be obtained that does not envisage room for growth of population

The capacity of the land to bear increased population is of vital importance. Even before an area is fully utilized, impoverishment of value and decrease in productiveness nearly everywhere is a potential and often an actual threat. Somewhat tardily it has been recognized that every productive area has a limit to the demands that can be made on the land; and this limit is not merely one of soil fertility, important as that is, but is intimately bound up with rainfall and its fluctuations from year to year. Deserts advance through human folly rather than by change of climate.

There is another side to this large-scale migration, and that is the effect on the lands of origin. With the exacting demands of the States receiving emigrants as to good physical and moral stock, there is a drain of the best and an increasing pool of the weakest in the homeland. The wider world, where open to colonists, insists that no imperfect stock shall enter. Economically also, the drain, if confined either to agricultural or to industrial population, may have harmful effects on the home country in disturbing the balance between rural and urban life, and checking one or another aspect of production.

In his address as retiring president of the American Association for the Advancement of Science delivered at Ohio on September 11, part of which is printed on page 5 of this issue, Dr. Isaiah Bowman dealt with problems of this nature, and showed that the solution

can be found only by the scientific study of environments leading to an understanding of their capacity for population of different degrees of culture and economic development. In practice, most of the areas of settlement of high potential are marginal lands; this intensifies the problem, but makes more insistent a scientific survey of their capacity. Some lands will require considerable capital outlay before they can be regarded as satisfactory homes. The Soviet Union has found that to be true of its subarctic domain and has succeeded in implanting a considerable population in lands formerly regarded as useless.

This scientific study of environment is peculiarly the province of the geographer, who in correlating the complex functions of the many factors involved can give realism to the study of phenomena which in separate isolated studies are liable to become abstractions. A mere descriptive study will not suffice, nor will a purely analytic study help. There must be correlation between the exact physical factors and the variable human factors before any sure ground on which to base predictions is reached. The problems to be solved in transferring populations are concrete ones that need the illumination of the scientific outlook, and cannot equitably or with stability be solved on the grounds of mere political expediency. This applies both to the newer marginal lands and to the older populated lands, even if the weight of the various factors varies in different cases.

CONSTRUCTIVE DEMOCRACY

T V A

Democracy on the March. By David E. Lilienthal. (Penguin Special, S.151.) Pp. 208+15 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 9*d*.

The T.V.A.

Lessons for International Application. By Herman Finer. (Studies and Reports, Series B: Economic Conditions, No. 37.) Pp. viii+289. (Montreal: International Labour Office; London: P. S. King and Staples, Ltd., 1944.) 1.50 dollars; 6*s*.

THESE two books make an admirable supplement to the account of the Tennessee Valley Authority which Dr. Julian Huxley gave us last year. Their scope is sufficiently indicated by their sub-titles. In the first, Mr. David E. Lilienthal, chairman of the Tennessee Valley Authority, gives us from inside an interpretation of this great experiment in regional planning, as much from the point of view of its significance for the future as from that of narrating its technical and social achievements up to the present. This is the more popular of the two books. It is ably written and well documented, but endeavours to indicate the spirit rather than the technical detail of the achievements in the Tennessee Valley. Mr. Lilienthal is at pains to make plain the factors which have contributed to its success in the face of much strenuous opposition and misrepresentation.

The extent to which he has succeeded in this aim is indicated by the place which the book must assuredly take in the discussion of the machinery of democratic government. It is a major contribution to that debate on the relations between central, regional and local administration which must be faced in Great Britain if any effective solution is to be found to the problems of reconstruction, town- and country-planning and the location of industry. Mr. Lilienthal indicates at once the way in which the dilemma between planning and freedom may be resolved and in which fresh life may be brought into our democratic institutions by giving local interest and initiative more effective scope.

It is thus as a contribution to constructive thinking about planning, the demonstration that the regional planning of resources in conformity with broad national objectives and policies is possible, with full participation, through decentralization, of the people themselves, that the book has its greatest value. Technical achievements are only incidentally described, but Mr. Lilienthal has fully recognized that the experiment has involved solving the problem of the use of the technical expert in government, and that it is an experiment in government as well as in the development of national resources. His chapters on "Experts and the People", "Decentralization", "Regional Pillars of Decentralization" and "Modern Tools for a Modern Job" are not only lucid expositions of the way in which T.V.A. functions but also a contribution to the literature of scientific administration.

In his chapter "T V A and World Reconstruction", Mr. Lilienthal touches on the other factor which has given the Tennessee Valley Authority its general interest at the present time, and which is the main theme of Dr. Herman Finer's book. If this book is less well documented, it is more fully provided with statistical data, and the factual account of the Authority's achievements is more complete. The emphasis on the administrative machinery is similar: there is the same stress on the balance between a national plan, regional development and local co-operation, on the social as well as the technical objectives, and the establishment of the right relations between knowledge and power.

Five of the fourteen chapters of the book are in fact devoted to staff and administrative problems—the corporate agency and its methods of operation, management and personnel, Federal controls and State relationships, the employee relationship policy and labour, and employee welfare services, with which Dr. Finer has himself been more particularly concerned. Although much of this is relevant rather to American than to British conditions, and regard should be had to the fact that the United States, generally speaking, is a generation or two behind Great Britain in its labour policies, Dr. Finer argues with some reason that T.V.A's methods and experience indicate conclusively that public enterprise can attract to, and retain in, its service men and women who will work continuously with devotion and initiative. If they are given work, scientific or administrative, in office, laboratory or field, with a demonstrably high social value; if the work has meaning for them; and if there is security for the continuance of the service and of the livelihood it provides, they may be expected to serve with high, sustained, and increasing efficiency, free from undue envy and acquisitiveness. Nor are Dr. Finer's conditions wholly irrelevant to service in private as well as public enterprise.

The most important chapter in the book, however, is the concluding one, in which Dr. Finer discusses the problem of an international T.V.A. His examination of the functions and operation of the T.V.A. was undertaken, first, to record an experience valuable

to those generally interested in the possibilities and conduct of public development works, but more especially to distinguish the problems facing an international agency seeking to assist the development of the resources of under-developed countries. It is in this chapter that Dr. Finer gives us the full measure of his quality, and for this alone the book would be a major contribution to the literature of post-war international reconstruction. It is a sound corrective to whatever extravagance there may be in the expectations raised by the growth of public opinion vaguely favourable to the establishment of such agencies on the precedence of T.V.A.

No such model, Dr. Finer points out, can be regarded as suitable for adoption in every identical feature by other countries. T.V.A. is not transplantable without reservations and qualifications, but its characteristics help to bring out the problems and suggest alternative solutions. T.V.A., as Dr. Finer points out, was the answer to a complex of economic and social problems, which involved the relationship between a nation and one of its regions, poverty-stricken, but with resources capable of development. This lucid analysis clearly indicates the problems involved and the factors of which account has to be taken—the relation between the region and the national or world economy of which it is a part, the necessity of any country seeking international assistance first providing a comprehensive scheme of development, the financial problems, the importance of clear definition of scope of powers, the relation between development schemes and social progress, the importance of training both workers and managers. In his survey of problems of international assistance, Dr. Finer recognizes the room for "wide range of diversity", nor does his caution lead him to strike any the less confidently than Lilienthal or Huxley the note of hope.

The Tennessee Valley Authority has clearly shown the way democracy can march forward. The clear understanding of what is involved in that experiment and of the factors responsible for its success should at least assist in an apprehension in Great Britain of post-war problems of reconstruction and development, national and international, which will increase the prospects of the right measures and solutions being found and implemented. R. BRIGHTMAN.

ELLIPSOIDAL WAVES OR RELATIVITY?

Propagation Ellipsoïdale, Relativité, Quanta
Par H. Varcollier. Pp. iii+398. (Alger: Baconnier frères, 1942.) 20*s*.

"IT is the customary fate of new truths," said T. H. Huxley, "to begin as heresies and end as superstitions." In at least one large London college, relativity was for some time regarded as a heresy, or at best a kind of pure mathematics that had drifted out of touch with reality. Now we believe that relativity is the only theory that can explain certain experimental results. This belief is mere superstition unless we are prepared to examine alternative explanations, such as that offered by M. Varcollier.

In an earlier book, "La Relativité dégagée d'hypothèses métaphysiques" (1925), he claimed that there were several hypotheses which could explain the Michelson-Morley experiment without abandoning classical ideas of space and time. He has now worked out in considerable detail the consequences of one of these hypotheses, namely, that the wave front due to a source moving in a straight line with velocity v is a prolate ellipsoid the centre and forward focus of which are respectively at the initial and instantaneous positions of the source. In other words, the wave front differs from the usual sphere of radius ct in that the diameters perpendicular to v are contracted in the ratio $\sqrt{(1 - v^2/c^2)} : 1$. This makes no appreciable difference to the common phenomena of optics, for both hypotheses give the same velocity in the direction of motion, and the normal velocities are in the ratio given above, which for ordinary values of v is hard to distinguish from equality.

Several chapters are devoted to the mathematical development of what we may call the "ellipsoidal theory", and many of the results differ only slightly, if at all, from the corresponding results of relativity. In particular, we find a complete analogue to the Lorentz transformation. The climax is the 'ellipsoidal' explanation of experiments which are usually cited in support of relativity. Although M. Varcollier's theory is not compatible with the relativity postulate of the *universal* constancy of the velocity of light, he obtains a constant total time for the double journey of a ray such as occurs in the Michelson-Morley experiment. He is equally successful with another negative experiment, that of Trouton and Noble. Coming to the positive experiment of Doppler-Fizeau, with a law for the composition of velocities which, to a high degree of approximation, is the same as that of relativity, M. Varcollier gets an approximately equal result. In the case of Sagnac's experiment, so embarrassing for the whole-hearted believer in the relativity of rotation, in which light travels in opposite directions round the circumference of a rotating disk, M. Varcollier obtains the well-known formula, confirmed by experiment, for the displacement of the interference fringes. This arises naturally from his idea of absolute space; he is scrupulous in pointing out that in this case the 'ellipsoidal' hypothesis is not essential, as a spherical wave front would give the same result.

So far the author has done very well, but it is surprising to find no reference to the eclipse results, the advance of the perihelion of Mercury, or the spectral shift of light from the sun. Yet it was these three pieces of evidence, or at any rate the first two of them, which were chiefly responsible for raising relativity from a heresy to an orthodox tenet.

There is a final chapter (Chapter 9) which it is not fair to criticize in detail, as it is avowedly only a sketch of possible extensions of the preceding principles. It contains, among many other things, a new theory of the motion of an electric particle, with remarks on nuclear magnetism, the proton, the neutron, and the Bohr magneton. There is also a new quantum mechanics, in which it is emissive orbits that are quantized, a breach with the accepted theory that is explicitly acknowledged. However Planck's constant and Sommerfeld's equation reappear unchanged, and the fundamental Rydberg-Bohr spectral formula is not much changed.

Whatever may be thought of M. Varcollier's results, we can all admire the courage which sustained him, in the darkest hour of his country's history, to continue his researches and to complete them for publication in Algiers, far from the facilities of Metropolitan France. H. T. H. PIAGGIO.

LAND SETTLEMENT AND RESOURCE DEVELOPMENT*

By Dr. ISAIAH BOWMAN
President of the Johns Hopkins University

Choice of Essentials

IT may be assumed that well-organized peoples work within the limits of more or less deliberate choices of essentials as modified by the accidental and the unpredictable To-day the people of the United States insist on a high standard of living as one choice among a number of essentials, because access to the world's wealth, or the power to create it, are now taken for granted, thanks chiefly to geographical discovery, the inventions that have grown out of modern physics and chemistry and the crop changes due to plant introductions and plant breeding. In Britain, the post-war standard of living has at times seemed as important as the War itself. Housing now has first priority in post-war plans, civilian supplies second, and manufacture for overseas trade third. It is held that the War will not seem won to the returning soldiers if decent places to live in are not assured.

How to marshal our forces in support of the great ideas we intend to live by has now become one great essential Resource development is tributary to that. We cannot lay out the lands and dominions of the world and disinterestedly observe where and how development should proceed to give us a rational scheme. We are not free in this respect. Our fate is now bound to other lands far and near There is no such thing as 'pulling out' of a world war or the peace that follows it. The fine net of world circumstance entangles us all. This is the political context of land settlement and resource development from now on.

If this reasoning be sound, we must look at marginal lands not as permitting, but rather as compelling, action Some of the largest tracts are in the British Empire. Canada and Australia have too few people, considering the territory they embrace and its strategic value. It is urgent business to fill these under-developed lands. The population structure of the British Isles is such that a decline is forecast to thirty-two millions by 1976 (Carr-Saunders). Half the assumed rate is alarming enough. A general overseas movement from Britain to the distant Dominions is therefore out of the question. Where shall the non-British migrants be found who will most readily people the Dominions? In Europe certainly, but this clearly means the designation of desirable stocks, encouraged migration and a certain measure of accelerated nationalization. The last-named is necessary for purposes of unity (through education) in essentials of community life, and for the political cohesion that self-protection demands. If migrants are without education in the history and traditions of the country to which they migrate, or the capacity to benefit by them, they may weaken a nation in a period when cohesion and strength are matters of life and death.

If there is agreement on these essentials, we must aid the settler in choosing the best lands for given crops, the best cultivation techniques for quality and the best market conditions, as well as the limits of production in relation to price levels. The virility and imagination which Mackinder invoked on Britain's behalf in 1902 as he looked at the perilous facts of British geography, demography and power, are now most urgently required by all of us. The insularity of the British Isles is only different in degree from that which marks the present situation of the United States. Our great strength is sustained in part by drawing upon a wide range of foreign products. Any human stock that has staked out its portion of earth as the home of free institutions must now effectively occupy and defend what it claims. Having chosen a course, every support that science, sense and experience can bring should be marshalled to people the best remaining lands with assimilable stocks capable of making a sound choice of essentials.

The word 'assimilable' is important. Political unity is short-lived unless continuously nourished. Land settlement in the post-war period starts with people. Land is secondary. We cannot create a special citizenship bound to the land Only the serf and the bondsman are so restrained. It is alleged that the only Venezuelan agricultural colony settled by immigrants since the colonial era that has survived to the present time is Colonia Tovar. It is in the coastal Cordillera, twenty-two miles from La Victoria, and was founded by Codazzi a hundred years ago. W. D. Rasmussen concludes that its unique success is a reminder to Venezuela "that it would not be advantageous to have the Nation's unused land settled by isolated frontiersmen on a subsistence level or by nationalistic groups. Social and economic integration are essential"[1].

The integrating powers of States differ as much as their physiography and economic life, education, sports, speed and volume of circulation of newspaper and mails, and all the other attributes of culture differing so widely. That is why a world-imposed theoretical plan of settlement would most certainly fail, whereas national programmes inspired by disinterested local studies of a scientific nature may succeed.

Over-all Conditions: A Basis of Judgment

If the limits of land settlement are to be drawn strictly on the basis of immediate economic returns, there will be no general venturing. Success demands an immense excitement about settlement, but an excitement controlled by a choice of essentials, the social context, the scientific findings, the deliberate choice of things it is meant to do and pay for, whether they are economic or not. Sound conclusions as to what is or is not economic in pioneering are few in number. Medical science has a good word for the assemblage of over-all conditions upon which a judgment must be based. The word is 'syndrome'. It is defined as 'a group of signs and symptoms that occur together and characterize a disease'. Fever is the accompaniment of many diseases. The same is true of pain. But one diagnoses a given case by the things that occur uniquely together.

This 'occurring together' is characteristic of each type of marginal land. It is worse than useless, it is misleading, to say that the average rainfall of a certain area is sufficient to support good crops four years out of five and therefore it is safe to engage in wheat and barley cultivation or cotton or corn. The interpretation of rainfall in terms of crops is but one

* Portion of the address of the retiring president of the American Association for the Advancement of Science, entitled "Commanding Our Wealth", delivered at Ohio on September 11 and published in full in *Science* of September 15.

factor in an extremely complex set of circumstances.

Each crop and each method of cultivation must be studied in relation to each soil type, each vegetation type, each rainfall type, each slope gradient, in combinations that must be analysed fundamentally and not in the light of a particular political thesis. Good objects from one point of view may be achieved at the expense of other equally good objects.

"The station holder [of New Zealand] most 'efficient' in the eyes of his neighbors . . . (in that he frees his hill country of weeds) is often the first to be driven off his holding by advanced erosion. Soil losses are widespread and serious and it is evident that remedies successfully employed in the United States can not be used in New Zealand without considerable modification. In individual regions the problem is unique: each region will require its own solution. The immediate and urgent need is for research and experiment. Effective soil conservation implies the kind of use and treatment of land that exactly fits its capabilities and needs"[2].

The example of tsetse fly control illustrates a conflict of purposes and results that can only be resolved by intensified scientific studies. Each of the twenty-one species of fly has different habits and different requirements as regards vegetational habitat. These differences bring each species in contact with different combinations of food animals. Each species also has a range of habitats.

"Hence the subject resembles the song of the 'Ten Little Nigger Boys'. As you find the solution for one type of country, nine types remain, and so on. But we are finding one thing in common for all the tsetses; each requires more than one vegetational type at a time, and the types it requires must be in contact with one another to support it in all seasons and years. We call this 'concurrence of requirements'. *Glossina morsitans*, for instance, needs savanna wooding to rest and breed in, and vleis to search for food in. Continuous uniform savanna wooding will not support it, while ant-heaps with heavy vegetation, near or at the contact of this and the vleis, add much to the suitability of the general vegetational concurrence. This simplifies the problem very greatly. It means that you need eliminate, by planting or otherwise, only one requirement of the tsetse at one season of the year—or (it may even be) of an exceptional year—in order to eliminate the tsetse"[3].

Conflict of purpose is underscored in the final report of the Drought Investigation Commission of the Union of South Africa (1923). The destruction of the natural vegetation increased soil erosion while decreasing the underground water-supply, thus making more difficult the watering of stock. Complaints having been made by farmers that the planting of catchment-areas in South Africa with fast-growing conifers and eucalypts has diminished the dry season water-supply in certain streams, a special committee of the Fourth British Empire Conference in 1935 considered the problem. In view of contrary evidence and the concurrence of a period of diminished rainfall, the complaints were discounted; nonetheless the committee pointed out the desirability of a comprehensive scientific investigation into the effects of tree-planting on local water-supplies. The lack of scientific knowledge through controlled experimentation could only be made up by precautionary advice. Quoting again from "Colonial Forest Administration":

"In the meantime, in order to allay public anxiety, it was suggested that where water conservation was a vital matter, fast-growing exotics should not be planted at the actual sources of streams and the eyes of springs, where, however, the natural vegetation should be carefully protected There has never been any question as to the value of the indigenous forest as a means of conserving and regulating the water-supply"

The limited application of scientific results from a single area is a truth that drives home the need for intensive studies, area by area. The combination of controls, risks and needs is often unique. The warning is given that:

"Because the white farmers on the karroo sediments of the Cape Colony, or on the dolomites of the western Transvaal have been saved by an energetic policy of providing bore-hole water with the aid of 'forests of windmills', a similar policy will not necessarily help nomadic Masai or semi-nomadic Sukuma on the old metamorphosed schists or granites of Tanganyika Territory. In Tanganyika Territory, as elsewhere, the layman is apt to shout for irrigation schemes without knowledge of their implications. Only recently one read in *The Tanganyika Standard* . . the following statement . . . 'Vast areas in the Territory are entirely waterless. This can be altered by a series of canals from which irrigation streams could be made'. It all sounds so wonderfully simple and straightforward! Matters with regard to first cost, salinity and lack of suitable soils become even worse in those parts of the territory where, in the absence of perennial rivers, irrigation of the reservoir type would have to be resorted to. One is, therefore, forced to the conclusion that large-scale irrigation schemes should be left severely alone and that in the light of a recent fuller understanding of the complications of climate, soils, hydrography and markets the early optimism of the Germans regarding the possibilities of such schemes can no longer be upheld"[4].

Brazilian and Peruvian Examples

A useful contrast has been drawn by M. L Cooke, in "Multiple Purpose Rivers"[5], between the São Francisco River in Brazil and the Amazon, the Amazon being limited by the fact that it is not a 'multiple-purpose' stream. Throughout its course in the lowlands there is no opportunity for electrical development and no proved coal deposits. By contrast the São Francisco Valley has a good alluvial floor, irrigable acreage "as much as that of cultivated Egypt", and good sites for dams and power plants that would extend water control and power development and provide the manifold services and opportunities that now make the valley "socially inert for lack of a plan".

Social inertia has many facets Is its source in diet, or the extent of the tradition that manual work signifies reduced status? Or is it due to the prevalence of malaria and dysentery? Is a bad transport system contributory? The settlers from Ceará, a region of recurrent droughts, plus others from Rio Grande del Norte, Paraíba, Pernambuco and Alagoas, represent a new migration drift through the São Francisco Valley[6]; 160,000 left Bahia for São Paulo between 1936 and 1942, a large number from the valley itself. From the port of Joazeiro the bulk of the migration tide moves upstream by riverboat. Permanent settlement in the valley, despite the tide of potential

settlers, is scant and the population density remains low because of the inflexible pastoral pattern and the semi-aridity.

The slightest increase in population is apt to upset the delicate balance between population and resources which has been achieved as a result of the natural ebb and flow of humanity over a period of centuries, "and may easily strain beyond the limits of elasticity the carrying capacity of existing wells or pools, natural or artificial Not until the vise-like grip of the present extensive economy is broken and the use of the water rationalized, can there be sufficient progress in the valley to make possible an increase in population".

The settlement possibilities of the Amazon have always stirred the imagination of travellers, sometimes for and more often against intensified occupation. Some overlook the profound handicaps of isolated settlements as set forth in a useful medical survey by M. H. Kuczynski Godard[7], of the selva of the Rio Perené in Perú, with a chapter on Amazonian colonization in general. No report shows more clearly the necessity for writing the terms of settlement of the Amazon Basin and its borders in their social context rather than in terms of the imagined possible. It is immensely costly to give modern medical services to settlements so widely dispersed, and health conditions are in general deplorable Godard emphasizes the desire of enterprising persons to leave the region for more comfortable and more sanitary places, a negative migration which steadily drains off the best There results a tendency on the part of white settlers to remain stationary, primitive, morbid, hopeless. This brutal land is a sign of God's power, wrote Bustos, in the purple terms of the romantics. If we say that the Indian has adapted himself to it, the answer is given that to master his environment he has spent all his energy and has done nothing more. He exists without change. His religion is magic, and tradition and fear perpetuate it. For the whites, education, medical services, and enterprise through outside aid are prescribed Government recoils at the expense. It is held that there are safer and more comfortable places for enterprise.

The border of the Amazon basin may one day display a different aspect. That border is an empire in itself. It has the climatic and vegetative diversities of varying altitudes. It has access to the highlands on the west in Bolivia, Perú, Ecuador and Colombia. It is the exception to the gospel of land scarcity in Perú, as set forth recently by R. A. Ferrero[8]. Relaxation from the continued high temperatures and relentless humidity can be found most readily by locating settlements near the upland mountain borders of the basin and at moderate altitudes. Local air conditioning in the lowland plains will give temporary relief; but it is no substitute for a change of scene and climate.

Of social life in the pioneer zones of Brazil, in general, James writes that "the 1938 immigration decree requires that each colony established in the pioneer zones must have at least 30 per cent of people born in Brazil, and not more than 25 per cent may be composed of foreign people of any one nationality". In the rural schools part-time instruction must be given in Portuguese, and Brazilians must direct the schools.

"The possibilities of settlement in the pioneer zones of Brazil cannot be understood or predicted from a study of the physical quality of the land alone . . . the kind of people who may desire to undertake the settlement of Brazil's pioneer zones can not at present be identified, nor can we know what political and social ideas or what technical abilities they will bring with them. Beyond a program of mapping, analysis of the physical quality of the land, interpretation of the present patterns of settlement and of past experience on different kinds of land, the prediction of future population capacity involves too many unknown factors to be profitable"[9].

Meanwhile the problem becomes more and more pressing · "Brazilians have become increasingly worried over the doctrine that vacant land is the patrimony of mankind and should not be allowed to remain idle while millions of humans live on a low standard because of lack of sufficient land. . . . The millions of acres of absolutely unused lands in Brazil, the failure to develop the rich deposits of iron, manganese and other minerals caused a natural uneasiness, a recognition that weak nations have always been absorbed by strong ones, that as Bismarck once remarked, natural riches in the hands of those who do not know how to develop them, nor care to do so, are a permanent danger to the possessor. . . ."[10].

Regional Framework of Settlement

The problem of future migration and settlement is complicated by runaway population-growth in a few countries and the demand that other countries make room for the excess no matter at what cost to social and political cohesion and living standards. Here politics, religion and national ambition are joined fatefully. There can be only further trouble in the international field if we assume that the subject is one so delicate in politics and religion that it may not be talked about It is equally dangerous to follow the course advocated during the past few years and deny the importance of national boundaries, as if one could change them freely to suit the changing demographic conditions of the world and let populations stream out in every direction at will. Such a policy of progressive revision would be an invitation to constant emotional pressures, to ingenious inventions of argument, to the destruction of treaties by violence, to the undoing of every form of international co-operation.

The possibilities of greater concentration of population in the already densely peopled industrial regions has been emphasized during the past twenty-five years. Primary production requires no forced expansion of settled areas, so long as technology supplies new avenues for investment and employment and corresponding concentration to suit the expanding tastes and diversified needs that technology has already stimulated. As new industries make new demands upon primary production in overseas lands, especially in tropical areas, both the income standards and the demand for manufactured goods will be raised.

"The unemployed in European industrial areas would then find employment at home in producing the things exported to tropical countries. . . . The need for emigration decreases with the opening up of such opportunities at home, and as this process is both theoretically in accord with the tertiary stage of industrial development, and has already been occurring on a large scale in practice, we must infer that centripetal movements of population are likely to be more important than centrifugal in future. In a reasonable world the European is likely to benefit most by the elaboration of his skill in his own land.

Given a relaxation of economic barriers, 'Europe is perhaps of all parts of the world the best suited to support a larger population'. If this dictum seems surprising it is only because we have fallen into the error of confusing high density of population with population pressure"[11].

The theory has been advanced and merits close examination "that differences in density were not causes but rather results of migration, that the basic cause of migration lay in differences in standards of living not necessarily correlated with density of population". An Italian example illustrates the point. The greatest increase in the rate of emigration during 1876–1925, concludes Forsyth, was in sparsely peopled agricultural districts, "a fact showing 'the falsity of the prevalent opinion that there is a direct relation between emigration and density ; in fact no such relation appears and in many cases the reverse relation is found' ".

The mounting scale of home investment in all countries is emphasized by many analysts ; likewise the requirement, in overseas agricultural settlement on any large scale, of very great capital sums. "If a country complaining of surplus population could find these sums, it would do much better to consider first whether the money could not be better used at home in stimulating industry so as to furnish employment and raise domestic standards, permitting meanwhile such emigration as could take place without public assistance"[12].

Migration and Boundary Stability

To change national boundaries capriciously would be the highest folly, in my opinion. We cannot undo two hundred years of history by light-hearted talk about the rearrangement of the populations of the world, as if densities could or should be smoothed out. To attempt to do this would at once bring into fatal conjunction differences in food habits, in standards of family life, in that virility and choice of essentials that are required successfully to defend one's own against robbery by war, and in all the other things that we label culture or purpose or ideals. Populations are not mere aggregates of numbers densely peopling the earth here and lightly peopling it there. We must look at the moving spirit of each aggregate. If purposes and ideals disappear, then we are mere livestock and our fate does not matter. It is the ideal toward which we strive that gives our national life a purpose. All these things confront us when we think responsibly about changes in national boundaries. We cannot overlook the importance of property lines, legal administration, taxation and all the other attributes, powers and responsibilities that go with political and purposeful control of specified territories. The nations will certainly not mingle land titles and effects, any more than they will mingle codes and culture systems, or water them down to some common scheme that means nothing to anybody.

To be specific, free migration and elimination of boundary restraints would not solve any identifiable problem of distributing the annual increment of five millions of Indians in other countries. It would only weaken, confuse and distress the rest of the world. Whatever outside responsibility there may be, the Indians also must do something at home about that increment. As for outside responsibility, consider the shipping required to transport overseas five millions, or even one million a year. Consider the social services required to establish them in new places. Consider the communities that they would form of unlike peoples with ideals, historic backgrounds, culture systems, family life, religion, etc., so unlike their neighbours in their new environment. Further, there would be neighbours almost everywhere. A million Indians cannot be dumped into the Amazon basin in a given year or in five years, for the supply of social services is at a minimum there and adequate services cannot be improvised : they require time for seasoning through experimentation. Power, humanely exercised, has the responsibility of saying how it would absorb what that number of settlers would produce from a forested and savanna terrain. Brazil has the responsibility of saying whether she desires an Indian empire in the Amazon, were one possible of creation. Whether we assume its divisive political influence or its economic and social failure, the problem would be on Brazil's shoulders if she ever attempted so bizarre a social enterprise as wholesale settlement of immigrant Indians in Amazonia. Social and political cohesion worries Brazilian leaders now ; they are not likely to invite an enlargement of the area of difficulty.

The nature of some of the problems that arise when two cultures are placed side by side may be inferred from the experience of Fiji. In 1940 nearly half the population was Indian (98,000 out of 220,000).

"Indians have picked out many pieces of good land near native villages and leased them, and the improvident Fijian has been compelled to carry on his agricultural methods on poorer land farther away from his native community. . . . The 'use' of land in the mind of a native is not confined to his need for an area large enough for growing foodstuffs. He desires to retain freedom to search for wild food, for materials for building houses, and to hunt for wild pigs. . . . Young Indians assert : 'There are thousands of acres in Fiji not being used. We are British subjects and we want some. We were born and reared here'. . . . The question of landownership and land use is not only important to those who own the lands but is also of vital importance to the Indians who have made their homes in Fiji. Bound up with it is the future welfare of the colony. Native chiefs passed a resolution in 1936, asking, in effect, that the government should control for them all the lands they did not require"[13].

We have already noted inequalities of population density, opportunities, standards of living and political ideals that are bound up with questions of migration and settlement. Behind these inequalities is a conflict of philosophies. In the world of the future a balance of ideas as well as a balance of power may have to be reckoned with. Some students believe that industrialization will start, or at least accelerate, the desired cycle of conditions that lead to reduced birth-rates. Others contend that this will endanger the world's peace by placing greater power in the hands of politically immature peoples.

In a broken world, migration on a large scale is not politically feasible. Employment is an intense preoccupation for the city-half of our population. The War has taught us the crucial need for internal unity. The risk of turbulence implied by the wholesale shifting of populations is shunned by every country. The occupation of the remaining lands, a highly desirable end, thus becomes an outward growth from established bases, with science and government sharing the task, the factors of time and personal initiative being taken into account.

Scale as a Factor

The sense of enterprise which permeates successful settlement endeavour depends nowadays upon well-selected sites and a certain scale Population centres of 3,000–5,000 are required, as well as smaller centres and individual farms, if the varied services that make new homes acceptable are to be supplied. To develop smaller towns or isolated villages of a few hundred, or to go back to lone pioneering, is to call for too great a change in the way of life of present-day settlers The larger size will also have a conspicuous effect in drawing population from nearby well-settled areas where there may be less opportunity for land development. It is the extension of settlement from already established localities that provides the bulk of the population of pioneer groups. The Inter-Departmental Committee on Migration Policy, reporting in 1934, has a significant statement on the matter from the particular point of view of British overseas settlement.

". . . We find it very difficult to believe that organized group settlement could deal with, at the most, more than 2,500 families—say, 10,000 souls—in a year ; neither the localities, nor the capital, nor the administrative capacity for anything in excess of this—or perhaps for anything as large as this—are available. There are, however, no limits, other than the absorptive capacity of the Empire overseas, to the magnitude of the stream of migration which may be produced by the other method. [The prospective settler migrating with his family on his own initiative or that of a friend or relative] It was by this method that, in the ten years immediately preceding the war, over 148,000 migrants annually left the United Kingdom and settled in the overseas parts of the Empire In the ten years 1919–1928, the annual average migration produced by this method was over 132,000. We are convinced that it will be by this method, individualistic, and therefore congenial to our national bent, that the great bulk of migration from this country will always take place . . ."

The extremely important point is made that schemes for settling thousands of families overseas in new communities tend to impress the public by the magnitude of the organization involved, the sums expended and the new names of towns on the map. The bustle and publicity of ship chartering, port building, road construction, co-operative buying and selling and the selection of a balanced population containing the right number of farmers, tradesmen, professional men—all these activities create a stir and excitement that are alleged to have no corresponding practical results when it comes to the real business of counting new settlers and appraising their staying power on the land. But it would be more correct to say that the excitement is out of proportion to the results, thus recognizing the possible value of excitement.

The two methods are not mutually exclusive The bulk of the lands available for settlement, out of a world total of perhaps three million square miles, can be occupied by self-initiating settlers. There are some areas, however, that require substantial capital investments if success is to be attained. Government will be called on to take the risk of supplying such capital if the objectives include national security or other non-economic ends. We all remember the wide and sustained public interest in the irrigation projects of the U.S. Reclamation Service following the turn of the century. "Homes for Millions" became a popular slogan. Yet when the twenty-four national irrigation projects had reached the point of substantial development in 1926, there was a total farm population upon them of only 137,000. By contrast, in the two decades preceding, motivated by individual enterprise, there were more than 600,000 final entries under the Homestead Act, in addition to coal-land and desert-land entries

What the Reclamation Service did was important and desirable It undertook the large capital-venturing beyond the means of the individual farmer or the small group Were such capital-venturing to be undertaken for petroleum exploration in Alaska, for example, in parallel with advanced agricultural experimentation, it is possible that the struggling settlements of the pioneer fringe of Alaska would take on a new lease of life and that the enlarged scale of operations would create the excitements and sustain the hopes that are necessary for permanent occupation. But in the end it would be the push, virility and enterprise of individuals that would constitute the final test of staying power and attachment.

Contrasts in National Inventories

The contrast between east and west, about migration and land, in part grows out of our different purposes in using it. Land in China is for subsistence , land is food. In the United States land is one factor in the complicated problem of (1) keeping up a standard of living on the land so as not to sink farmers to the level of peasants ; (2) balancing the benefits of total production, city and country, through the intricate mechanisms of an industrial society.

We do not bring all our land into full production because we already have a surplus production (I will not venture into the tangled question as to whether or not this is only a commercial and not a social surplus.) By contrast, land division in India and China has been carried so far, under growing population pressures, that tens of millions are at starvation-level. The problem facing Governments is how to ease these conditions before Australia becomes an adjunct of India or China. Economic easement in China seems a far more rational solution than merely keeping Chinese out of Australia If white settlement in Australia is urgent, it is equally urgent to begin the industrialization of China. The balance of ideas and opportunity may thus become a sufficient substitute for the balance of power.

There seems to be a high correlation between prosperity in new lands and migration to them. Historically, that prosperity has been in turn dependent upon the power of industrial centres to buy the raw materials of the producers of the newer lands. If the post-war world enters an era of expansion (to supply the losses of war and delayed consumption demands), there seems to be a clear possibility that the former relation of industrial areas to raw material areas may be substantially regained. The act of industrialization of former raw materials areas in itself will augment the relative prosperity of the latter. There is no reason, therefore, why further settlement and industrialization may not go hand in hand.

Goals of National Policy

As a general working principle, the acceptance of a bare subsistence standard for planned pioneer settlement may be condemned as a national policy, whether in Australia or Brazil. But settlers on their own initiative will also be looking for small doors of

limited opportunity, not necessarily a gateway to the best the world affords. This may prove true of refugee settlement in particular. For refugees, a higher degree of tolerance of hard conditions has been assumed. Will it work out that way?

A scientific inquiry in each major area proposed for settlement cannot stop short of the goal of acceptable livings. Granted that there must be wide tolerance at first on the part of almost all settlers, can an inventory of resources, area by area, assure them diversified production and enlargement of opportunity with endurably brief delay? Since most areas of potential settlement are marginal, can scientific inquiry reduce the risks? One may be sure that vast sums will not be spent in the post-war years upon doles to settlers who are badly located. There is every reason, however, why initial aid should be given to well-placed units who will add to the resources and taxable wealth of the countries of their adoption.

The abundance of unused land strikes every observer, yet it is the scarcity of commercially valuable unused land that intensifies the problem. The scientific study of settlement has become to a large degree a study of unused land. What keeps it out of production? Is the soil deficient? Is the water supply undependable? Are the required cultivation techniques peculiar? What is the natural unbalance that must be corrected by scientific study and treatment? The tsetse fly, natural versus artificial vegetation, extreme price changes and soil erosion are among the examples we have mentioned.

No less important is a study in national psychologies. What is the attitude, country by country, toward the foreigner? What part in the shaping or retention of a recognized national attitude is played by experience with groups already established? Are the examples of Colonia Tovar, Cyrenaica and São Francisco correctly interpreted? What is the peculiar nature of the essential political processes in each country? How do the variant political processes play upon or determine migration policies? What are the specific economic equivalents of migration in industry and trade?

When the answers to these and other questions are given, not in the terms of a single specialty, but in the terms of a social and political mosaic, country by country, the science of settlement will have reached maturity. Sophistication of the investigator plays a part in finding practical answers: he must have that "nice tact of circumstances" which enables him to determine reasonably well what specific groups of men can do, or will do, or may be persuaded to do.

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SCIENTIFIC CENTENARIES IN 1945

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

A REVIEW of the scientific centenaries which will occur in 1945 may well begin with a quotation from the autobiographical notes of the English mathematician John Wallis (1616–1703), written when he was eighty: "About the year 1645," he wrote, "while I lived in London . . . I had the opportunity of being acquainted with divers worthy persons, inquisitive into natural philosophy, and other parts of human learning; and particularly of what hath been called the *New Philosophy*, or *Experimental Philosophy*. We did by agreements, divers of us, meet weekly in London on a certain day, to treat and discourse of such affairs. . . . These meetings we held sometimes at *Dr. Goddard's* lodgings in *Wood Street* . . . on occasion of his keeping an operator in his house for grinding lenses for telescopes and microscopes; sometimes at a convenient place in *Cheapside*, and sometimes at *Gresham College*, or some place near adjoyning.

"Our business was (precluding matters of theology and state-affairs) to discourse and consider of *Philosophical Enquiries*, and such as related thereunto: as *Physick*, *Anatomy*, *Geometry*, *Astronomy*, *Navigation*, *Staticks*, *Magneticks*, *Chymicks*, *Mechanicks*, and natural *Experiments*, with the state of those studies, as then cultivated at home and abroad. . . ."

From those gatherings and others at Oxford sprang the Royal Society, the first official record of which is a memorandum relating to a meeting on Nov. 28, 1660, held in Gresham College. "W. G." wrote:

> "At Gresham College a learned knott,
> Unparallel'd designs have lay'd
> To make themselves a corporation
> And know all things by demonstration."

Of the various subjects Wallis named, "Chymicks" was one which perhaps most needed the experimentalist to remove it from the realm of mystery. Jean Rey, a Frenchman, appears to have been such a man. He was born in what is now the Department of Dordogne; he studied medicine, corresponded with learned men and worked at practical chemistry. His death took place three hundred years ago, but in 1630, fifteen years before he died, he published "Essays de Jean Rey sur la Recerche de la cause pour laquelle l'Estain et le Plomb augmentent de poids quand on les calcine", which was thought worthy of republishing in 1908 and was reviewed in *Nature* of July 9, 1908. This memoir appears to anticipate the discoveries and views of Lavoisier by nearly a century and a half, but A. N. Moldrum (*Nature*, July 30, 1908) states that there is little evidence that Rey made experiments of any value in support of his views.

The year in which Rey died, his countryman Nicolas Lèmery (1645–1715) was born at Rouen. He lectured in Paris, spent some time in England as a Protestant refugee, but having embraced Catholicism, returned to France and was given a seat in the Royal Academy of Sciences. To-day he is remembered for his "Cours de chimie" (1675), which went through many editions and was translated into several languages. "The fine imaginations of other philosophers", he wrote, "concerning their physical principles may elevate the spirit by their grand ideas,

but they prove nothing demonstratively. And, as chemistry is a science of observation, it can only be based on what is palpable and demonstrative." The year 1645 has sometimes been given as the birth year of the English chemist John Mayow, but as Dr. Douglas McKie has shown, he was baptised in Morval Church, Cornwall, on December 21, 1641.

Passing to 1745, we have the births of Gahn, the Swedish chemist, of Etienne Montgolfier, the younger of the two pioneers of ballooning, of Schroter, whom Miss Clerke referred to as "the Herschel of Germany", and of the much more famous Volta. Johan Gottlieb Gahn was a student under Bergmann, a contemporary of Scheele and an associate of Berzelius. He was a chemist before he was a mineralogist, and a mineralogist before he became a metallurgist. Expert with the blowpipe, he was the first to isolate manganese. Montgolfier, too, was a chemist, as well as being a papermaker, and it was reading Priestley's memoirs which gave him some of his ideas The monument erected at Annonay in 1883 honours both brothers, and was erected to commemorate the centenary of their first full-scale experiment with a '*machine aerostatique*'.

Johann Hieronymus Schroter (1745–1816) was a worthy representative of that great band of amateurs who have furthered the cause of astronomy. Born at Erfurt, he became a law student at Göttingen and knew Herschel's musical family at Hanover. When thirty-three he was made magistrate at Lilienthal near Bremen, and there in his spare time studied the moon and planets. It was Schroter's assistant, K. L. Harding (1775–1834), who discovered the minor planet Juno, and when Harding went to Gottingen his place was taken by the young supercargo, Friedrich Wilhelm Bessel. Early in 1813, Bremen was occupied by the French, and in April Schroter saw his observatory pillaged and his books and writings burnt. He died three years later, a broken man. Though Volta, too, lived through the whole of the Napoleonic Wars, he suffered no such catastrophe. He was born at Como on February 18, 1745, and there he died in 1827. In 1899 and again in 1927, great international gatherings of scientific men were held at Como to mark the centenary of his most important discovery and the centenary of his death. Among Great Britain's representatives at the second meeting were Sir J. J. Thomson, Lord Rutherford and Sir Arthur Eddington.

Of the men of science who died a hundred years ago, few were better known than John Frederick Daniell, who expired suddenly on March 13, at a Council meeting of the Royal Society, of which he was at the time the foreign secretary. London born and bred, and educated privately, his devotion to science led to his admission to the Royal Society at the age of twenty-three. He worked with W. T. Brande, and on the establishment of King's College, London, was appointed to the chair of chemistry. The invention of the Daniell cell brought him the Copley Medal of the Royal Society. While Daniell was busy with his electrical experiments, the retired French watchmaker Jean Charles Athanase Peltier was engaged in much the same pursuits, discovering in 1834 the Peltier effect, the reverse of that made known thirteen years earlier by Seebeck. Peltier was born in 1785 and died on October 27, 1845. Nine days before this, the last of the Italian-French family of astronomers, Jacques Dominique Cassini, died at the age of ninety-seven. His father, Cesar François, had died in 1784 when seventy, his grandfather Jacques in 1756 when seventy-nine and his great-grandfather Jean Dominique in 1712 at the age of eighty-seven. For a hundred and twenty years a Cassini had been connected with the Paris Observatory, and the record was broken only by the upheaval of the French Revolution. The second and third Cassinis were especially active in geodesy, the great map of France being largely their work. After his dismissal from the Observatory in 1793 by the National Convention, Jacques Dominique, Compte de Cassini, retired to his estate and abandoned astronomy entirely.

Astronomers born in 1845 include Sir William Henry Mahoney Christie (died 1922), Astronomer-Royal from 1881 until 1910; Sir George Howard Darwin (died 1912), Plumian professor of astronomy and experimental philosophy at Cambridge from 1883 until 1912; Arthur Cowper Ranyard (died 1894), a founder of the London Mathematical Society and secretary of the Royal Astronomical Society, through whose efforts the tablet to Jeremiah Horrocks in Westminster Abbey was erected, and the distinguished director of the Paris Observatory, François Felix Tisserand (died 1896) The monument erected at Nuits-Saint-Georges to Tisserand was described and illustrated in *Nature* of November 23, 1899. His "Traite de Mécanique Celeste", it has been said, furnishes a faithful and complete résumé of the state of that department of astronomy at the end of the nineteenth century. In the United States, the year 1845 saw the completion of the Cincinnati Observatory, the first of any size in that country. Its erection was due to Ormsby MacKnight Mitchel, the author of "The Orbs of Heaven", a book which greatly influenced Sir Robert Ball when a boy.

Other workers in the exact sciences born in 1845 were William Kingdom Clifford, Gabriel Lippmann and Wilhelm Conrad von Röntgen. In the days of Huxley, Tyndall, Herbert Spencer and Leslie Stephen, there was no more notable figure in intellectual circles than Clifford, who died at the early age of thirty-four after occupying for eight years the chair of applied mathematics in University College, London. "He was admitted on all hands", said the *Athenæum*, "to be the most remarkable mathematician of his generation, and promised to be a second Cayley." Gabriel Lippmann, For.Mem.R.S., who died aboard the *La France* on July 13, 1921, when on his way home from Canada, was born in the Grand Duchy of Luxemburg, but practically all his life was spent in Paris. In 1886 he became director of the Physical Research Laboratory at the Sorbonne, in 1908 was awarded the Nobel Prize for Physics and in 1912 was elected president of the Paris Academy of Sciences. His process of colour photography was announced in 1891.

Clifford's name is known to relatively very few general readers to-day; Lippmann's to a more numerous but select circle; but the name of Röntgen is known everywhere. While March 27 will mark the centenary of his birth at Lennep, a few miles to the west of Düsseldorf, November 8 will be the fiftieth anniversary of his discovery at Würzburg of Röntgen rays, or as he called them, 'X-rays'. "Nov. 8, 1895", said Silvanus Thompson, "will ever be memorable in the history of science. On that day a light, which so far as human observation goes, never was on land or sea, was observed." The discovery was given to the world in Röntgen's paper, "Über eine neue Art von Strahlen", read to the

Physical-Medical Society of Wurzburg in December. There was universal recognition of the significance of the step made, and a translation of the paper was published in *Nature* of January 23, 1896. In 1897 the Rontgen Society was founded, but has since (1927) been amalgamated with the British Institute of Radiology. Though born in the Ruhr, Röntgen was educated in Holland and Switzerland. His appointments took him to Wurzburg, Strasbourg, Hohenheim and Giessen, then back to Wurzburg and finally to Munich, where he died on February 10, 1923.

Passing from the realms of the pure sciences to those of engineering, the year 1845 saw the birth of the versatile inventor and investigator Beauchamp Tower (1845–1905), who will long be remembered for his researches on lubrication carried out for the Institution of Mechanical Engineers. Carl Gustav Patrik de Laval (1845–1913), the Swedish pioneer of the steam turbine; Friedrich von Hefner-Alteneck (1845–1904), the German electrical engineer, and the Swiss hydraulic engineer Theodore Turrettini (1845–1916), were all equally versatile and inventive. With Lord Kelvin, Mascart, Unwin, Sellers and George Forbes, Turrettini was one of the Commission appointed in 1891 to deal with the problem of harnessing Niagara Falls. Karl Benz (1845–1929), the German pioneer of the motor-car, had few of the advantages enjoyed by the foregoing; but he left his mark on a growing industry. He began life as a workman in a Karlsruhe machine-shop, but at the age of twenty-six started on his own at Mannheim. There he produced, in 1885, one of the first vehicles driven by an internal combustion engine. In an entirely different field, we have the names of three eminent British naval architects, Sir William White (1845–1913), Dr. Francis Elgar (1845–1909) and William John (1845–90). All three were shipwright apprentices in the Royal Dockyards, and all three entered the famous Royal School of Naval Architecture and Marine Engineering at South Kensington, in 1864, the year it was opened. For a time their careers ran on parallel lines, but afterwards diverged, John becoming the manager of the Shipbuilding Yard at Barrow, now a part of Messrs. Vickers-Armstrongs, Elgar being nominated the first professor of naval architecture in the University of Glasgow, while White was for nearly twenty years director of naval construction at the Admiralty. By their labours Great Britain was repaid a thousand-fold what the Admiralty had spent on their education.

There was plenty of scientific activity in 1845, though not on the scale of to-day. For its fifteenth meeting the British Association made its second visit to Cambridge. Sir John Herschel was president, and one of the papers was by Joule, who described his paddle-wheel experiments for determining the relation between heat and work. After the gathering, Herschel wrote to Mrs. Somerville in Rome. "We had a full and very satisfactory meeting at Cambridge of the British Association with a full attendance of continental magnetists and meteorologists, and within these few days I have learned that our Government meant to grant all our requests and continue the magnetic and meteorological observations". One of the foreigners present was Von Buch, whom all the leading men of science had met at Dr. Fitton's in London. "At Murchison's request", wrote A. C. Ramsay, "I took Von Buch to Cambridge on the outside of the mail coach from the head of the Haymarket. His luggage consisted only of a small baize bag, which held a clean shirt and clean silk stockings He wore knee-breeches and shoes " Airy, of course, was at Cambridge and in the Senate House lectured on terrestrial magnetism, keeping his audience, as one writer said, "quite enchained for above two hours". Airy was given to long lectures, and on one occasion at the Royal Institution, his chairman, the Prince Consort, went to sleep. He was indefatigable. As if the directing of the astronomical, magnetical and meteorological work at Greenwich was insufficient occupation, in 1845 he served on the Railway Gauge Commission and a Harbour Commission, planned saw-mills for a dockyard, descended Cornish mines, nearly fainting at the bottom of one, and ascending another by Loam's man engine, "the finest operation that I ever saw", from France sent John Murray an account of the Cherbourg breakwater for Murray's "Handbook" and later in the year dined at York with George Hudson, the 'railway king'

Early in 1845 at Cambridge, a young man of twenty-one was second wrangler and first Smith's prizeman; one examiner remarking to another, "You and I are about fit to mend his pens". From the University the future Lord Kelvin went to Paris, worked in Regnault's laboratory, and through reading a paper of Clapeyron's learnt about Sadi Carnot's essay, but it took him three years to obtain a copy. Another Cambridge wrangler, Adams, of somewhat more mature age, twenty-six, the son of a Cornish farmer, in 1845 was devoting all his time to his self-imposed task of trying to discover if the behaviour of Uranus could be explained by the presence of a planet no one had ever seen. A young French astronomer, Leverrier, was doing the same thing Both arrived at the same conclusion, and next year a German astronomer found the planet. A very unscientific controversy arose in scientific circles, but to-day the world honours Adams and Leverrier alike.

The Royal Society in 1845 was in the midst of the long presidency of Spencer Joshua Alwyne Compton, second Marquis of Northampton, who following Davy's practice provided the fellows with tea. Samuel Hunter Christie, father of Sir William, was the secretary, John William Lubbock was treasurer, and after Daniell's death, Colonel Sabine was foreign secretary. The Copley Medal in 1845 was awarded to the Belgian naturalist Theodor Schwann, the Royal Medals to Airy and to the apparently forgotten Thomas Snow Beck, who had investigated the nerves of the uterus. At the Royal Institution, Faraday was pursuing his patient investigations, and in his diary under September 13, 1845, noted his success with glass and magnets, writing: "BUT when contrary magnetic poles were on the same side there *was an effect produced on the polarised ray*, and thus magnetic force and light were proved to have relation to each other".

As to the other scientific bodies, the Chemical Society, then in its fourth year, was presided over by Thomas Graham; the Royal Astronomical Society by Airy, who presented its Gold Medal to that very scientific naval officer Admiral William Henry Smyth, while the Geological Society elected as its president the "mild unpretending, differential" Leonard Horner. Geology was still a thorn in the flesh to the strictly orthodox, and on August 3, 1845, Mrs. Somerville wrote to her son: "The papers (I mean *The Times*) are full of abuse of Mr. Sedgwick and Dr. Buckland, but their adversaries write such nonsense that it

matters little". On April 1 the Geological Survey had been finally taken away from the Master-General and Board of Ordnance and placed "under the direction and supervision of the First Commissioner of Her Majesty's Woods, Forests, Land Revenues, Works and Buildings". The most important geological book of the year was the fine volume by Murchison and his associates, "The Geology of Russia in Europe and the Ural Mountains", dedicated to the Czar and containing coloured gold pin-pointed maps showing the mineral deposits from the northern extremity of the Urals to the Donetz Basin.

Experimental science still languished at Oxford and Cambridge, and in spite of the work of Graham at University College and of Daniell at King's College, London was sadly in need of chemical laboratories Largely through the Prince Consort, this need was met in 1845 by the opening in Oxford Street of the Royal College of Chemistry, where twenty-six students gathered to sit at the feet of a young *privat-docent* from Bonn, August Wilhelm Hofmann. In those far-off days, there was no talk of "blood and iron", "mailed fists" or "racial superiority", and there was free and friendly intercourse between German and British men of science, to the great advantage of both. Hofmann remained in London until 1864, but he came back later, his last appearance being in 1884, when he presided over the dinner given in honour of one of his most famous pupils, William Henry Perkin

By 1845 the peace had lasted thirty years and there was money to spend on all sorts of projects. The railway mania had set in, and Robert Stephenson was returning big cheques sent to him more or less as bribes. Some half a dozen railway lines, including those between Bristol and Gloucester, London and Cambridge and Manchester and Sheffield, were opened during the year, and as the railways spread so did the electric telegraphs. For a shilling, visitors to Paddington or Slough could see "this interesting and most extraordinary Apparatus by which upwards of 50 SIGNALS can be transmitted to a Distance of 280,000 miles in ONE MINUTE". The best advertisement, however, was the announcement of the arrest at Paddington through the use of the telegraph of the Slough murderer John Tawell. For the first time, too, a newspaper published a report of a meeting transmitted by electricity. Two years before, Colt, of revolver fame, had laid a submarine cable in New York harbour, and in Britain the Bretts were dreaming of a cable between England and France. Sea transport was undergoing a revolution. Steam vessels were found everywhere, iron shipbuilding was becoming an industry, and the trials of H.M.S. *Rattler* in 1845 showed the pioneers that screw propulsion was possible for even the stately three-decker line-of-battleship. By the spring, the famous iron screw steamer *Great Britain*, once called the *Mammoth*, was nearing completion, and on April 23, 1845, *The Times* said: "Yesterday Her Majesty and Prince Albert paid their contemplated visit to this extraordinary vessel". Brunel had the honour of explaining everything to the Royal party, and Francis Pettit Smith, otherwise "Screw" Smith, presented "a very beautiful model in gold, in an appropriate case, of the propeller he had recently fitted to Her Majesty's new tender yacht Fairy". The *Great Britain* sailed on her maiden voyage on July 26, 1845, and so opened another chapter in trans-Atlantic travel.

OBITUARIES

Sir John Fox, C.B., O.B.E., F.R.S.

JOHN JACOB FOX, eldest son of Mark and Hannah Fox, was born in London on April 12, 1874, and died on November 28, 1944. He received his scientific education at the Royal College of Science, South Kensington, and at Queen Mary College, London, taking the B.Sc. degree by research in 1908 and the D.Sc degree two years later. He was elected a fellow of the Royal Institute of Chemistry in 1916. He entered the Government service in 1896 and was appointed to the permanent staff of the Government Laboratory in 1904. He became superintending chemist in 1920, deputy Government chemist in 1929 and Government chemist in 1936.

During his official career, Fox was called upon to undertake work concerning a number of problems of interest not only to Government departments but also to the general public Among these the following may be mentioned: the possibility of substituting for white lead either less-soluble compounds of lead or 'leadless' glaze; the causes of the decay of buildings; the pollution of rivers by drainage from tarred roads, the cleaning and restoration of wall paintings His encyclopædic knowledge of organic chemistry and his sound judgment were called into play in organizing the sections of the Laboratory set up to advise the Board of Customs and Excise in the administration of the Safeguarding of Industries Act and of the duties on silk and artificial silk and on hydrocarbon oils. As Government chemist he was chairman of the Road Tar Research Committee and of the Committee on Physico-chemical Problems of the Building Research Board. In 1939 he threw himself with great energy into scientific matters connected with the prosecution of the War. This aspect of the work of his last years cannot yet be described in detail, but it can be stated that he served on numerous departmental committees and was a member of the Hydrocarbon Oil Duties Committee at the time of his death.

Fox found time to undertake a great deal of research. In his early years his mind turned to organic chemistry, and in this period he published researches in the acridine series and on the derivatives of 8-hydroxyquinoline and was joint author of the discovery of a new aromatic hydrocarbon diphenylene. Later he was interested in spectroscopy and its relation to molecular structure. The ultraviolet absorption spectra of alkaloids, sulphur, the halogens and light elements was studied. His work on the infra-red absorption spectra of diamond and of some carbon compounds, carried out in collaboration with colleagues in the Government Laboratory, led to the recognition of two types of diamond and to the elucidation of some difficult problems in analytical chemistry. Difficulties arising in his official work suggested researches on the solubility of lead sulphate in ammonium, potassium and sodium acetates, on mannito-boric acid and on the composition of some medieval waxes. He also published researches on new and improved methods of analysis.

Fox had a very alert mind, a photographic memory and abundant energy. In addition to the numerous research institutions to which he was appointed in his official capacity, he gave his time freely to the work of scientific societies. He was a past president of the Royal Institute of Chemistry, of the Oil and Colour Chemists' Association and a vice-president of

the Society of Chemical Industry. He served on the Council of the Chemical Society and was a manager of the Royal Institution. He always had at heart the welfare of Queen Mary College, its students and its old students. He was one of a small band of distinguished old students who met together several times a year to keep track of old members of the College and to give them a helping hand when necessary. He was made a fellow of Queen Mary College in 1937.

Fox was always willing to help: he never allowed red-tape to interfere with his official contacts with industry. He gladly saw the representatives of chemical manufacturers and other traders, and freely gave his knowledge and experience to help them to overcome those difficulties inseparable from governmental control. Although his whole life was devoted to the service of chemistry, he yet found time to act as treasurer of his church for many years. He was kind and generous to his colleagues and lost no opportunity of encouraging those young members of his staff who showed a lively interest in chemistry. His enthusiasm for chemistry remained to the end, when he could still be seen moving from room to room of the Laboratory—asking, suggesting, encouraging.

His services were rewarded by the honour of the O.B.E. in 1920, of the C.B. in 1938 and of a knighthood in 1944; his services to chemistry were acknowledged by the Royal Society in 1943, when he was elected a fellow. He leaves a widow, a son and a daughter. A. G. FRANCIS.

Sir Percy Nunn

THAT so distinguished a career as that of Sir Percy Nunn should have terminated in a sort of banishment from his native land, and therefore from the scenes and causes to which he had devoted his eminent gifts, must indeed be accounted a tragedy. So long as he was able to spend a few summer months in England, after many months of exile to Madeira for reasons of health, his lot seemed tolerable. But the grim course of world events meant for him complete exile, a condition which, however, his nobility of character enabled him to bear with exemplary patience and fortitude. He died on December 12 at the age of seventy-four.

That Nunn was first of all, at least in the chronological sense, a man of science, is shown by his first substantial piece of writing, his "Aims of Scientific Method", and by his subsequent work on the nature and teaching of mathematics. It is scarcely too much to say, however, that even then, and still more decidedly later on, when he became an active member of the Aristotelian Society, he was essentially a philosophic thinker. The broad philosophic outlook characterized all his literary work. He wrote a book bearing the modest and not uncommon title "Exercises in Algebra". The book must have been a sore puzzle to teachers who had not got far from the 'Hall-and-Knight' tradition. It was, in fact, the result of years of teaching combined with reflexion, and finally of many months of patient and laborious research in the British Museum and elsewhere. It could not be a best-seller in the secondary schools, but it could, and it did, help towards a reorganization of school mathematics.

At a later stage in Nunn's career, he published his well-known "Education: its Data and First Principles", a work which summed up in brief compass the substance of his courses of lectures on the subject. That book, published two years after the end of the first world war, was, for one thing, a marvel of prophecy as to the shape of things to come. The author's main purpose was "to re-assert the claim of Individuality to be regarded as the supreme educational ideal, and to protect that ideal against both the misprision of its critics and the incautious advocacy of its friends". The book, remarkable both for its clear vision and its massive learning, still stands as the finest systematic defence of the only educational ideal which can make the world safe for democracy.

Some of Nunn's old friends will remember how, as vice-principal of the new London Day Training College, he was introduced to them nearly forty years ago, by the principal, the late Sir John Adams, in a rather dingy little room near Holborn which formed the temporary headquarters of the College. Those were the roots, the fruits of which are seen to-day in the great University Institute of Education. That development was mostly due to the creative genius of one man, and that man was Percy Nunn. No longer is it necessary that teachers in the British Commonwealth of Nations should go to the United States if they wish to pursue advanced studies in education. They can now get what they want in England, thanks to the efforts of Sir Percy Nunn, and to those of his singularly appropriate successor, Sir Fred Clarke.

As the advocate of a cause, Nunn was a persuasively quiet and eloquent speaker. There was a marvellous flow of language, but every word told. He was a true and loyal friend and a delightful companion, and in his exile he liked to recall in his letters the days of small things in a distant past. T. RAYMONT.

Mr. J. Edmund Clark

JAMES EDMUND CLARK died on December 16 at the age of ninety-four. He was the last of the fourteen children of James and Eleanor Stephens Clark. His father died at the age of ninety-four, and the average age of his nine brothers and sisters who reached maturity was more than eighty-two when they died. His mother was one of a family of seventeen children.

Clark was educated at Bootham School, York, at University College, London, and at the University of Heidelberg. He returned to the famous Quaker school for boys at York as junior master during 1869–72, and after further training, he succeeded his life-long friend, later Prof. Silvanus P. Thompson, as science master at Bootham in 1875. After twenty-two years as a schoolmaster, he gave it up, largely because of deafness, and went to London in 1897, where he began a new career as export merchant. He retired in 1929.

Keenly concerned as Clark was for every branch of natural science, it was meteorology and phenology which particularly claimed his interest. For twenty-five years he was secretary of the Phenological Committee of the Royal Meteorological Society, and was for long a member of the Society's Council. High tribute was paid, when he retired in 1936, to his services to phenological studies on the effect of climatic conditions on natural phenomena.

In 1879 Clark married Lucretia H. Kendall, of Boston, Mass. She died in 1937, as did also their only son, Roderic. Throughout his life, Clark was a devoted and active member of the Society of Friends in York, Croydon, Purley and Street.

NEWS and VIEWS

New Year Honours List

THE following names of scientific workers and others associated with scientific activities appear in the New Year Honours list ·

Order of Merit : Prof. A. N. Whitehead, professor of philosophy in Harvard University.

Baronet · Sir Alfred Webb-Johnson, president of the Royal College of Surgeons.

K.B.E. : Sir Stanley Angwin, engineer-in-chief, General Post Office.

Knights . Prof. L P. Abercrombie, professor of town planning, University of London, Dr E B. Bailey, director of the Geological Survey of Great Britain ; Mr. F W Bain, chairman of the Chemical Control Board, Ministry of Supply ; Prof J. Chadwick, professor of physics, University of Liverpool, for services to the Department of Scientific and Industrial Research ; Dr. A. P. M. Fleming, a director of Metropolitan-Vickers Electrical Co., Ltd., for services to education ; Mr. R. G. Hetherington, adviser on water and director of water surveys, Ministry of Health ; Mr. W. P. Hildred, director-general of civil aviation, Air Ministry ; Mr. C. C. Inglis, director of the Indian Waterways Experiment Station, Poona ; Prof. E. H. Minns, emeritus professor of archæology and president of Pembroke College, Cambridge ; Diwan Bahadur Arcot Lakshmanaswami Mudaliyar, vice-chancellor of the University of Madras ; Dr C. W. B. Normand, lately director-general of observatories, India ; Mr. J. F. Rees, principal of the University College of South Wales and Monmouth, Cardiff, vice-chancellor of the University of Wales ; Dr. R. E. Stradling, chief adviser, Research and Experiments Department, Ministry of Home Security ; Bomanji Jamshedji Wadia, vice-chancellor of the University of Bombay ; Brig L. E. H. Whitby, lately bacteriologist at the Middlesex Hospital, for services in the development of the sulphonamide group of drugs ; Prof. E. T. Whittaker, professor of mathematics in the University of Edinburgh.

C.M.G. : Mr. D L. Blunt, director of agriculture, Kenya ; Mr. A. R. Callaghan, principal of the Roseworthy Agricultural College, South Australia, for public services ; Mr. G. C. Turner, principal of the Makerere College, Uganda.

C.I.E. : Daulat Ram Sethi, agricultural production and marketing adviser, India ; Mr. H. S George, chief conservator of forests, Central Provinces and Berar ; Mr. J. B. T Brooks, chief conservator of forests, Bombay ; Mr. F. C. Minett, director of the Imperial Veterinary Research Institute, Izatnagar-Mukteswar ; Rai Bahadur Tridib Nath Banarji, principal of the Prince of Wales Medical College, Patna.

C.B.E. : Mrs. Mary G Blacklock, the Liverpool School of Tropical Medicine ; Mr. J. P. Bowen, engineer-in-chief to Trinity House ; Mr. H. Campion, director of the Central Statistical Office, Offices of the War Cabinet ; Mr. H. J. E. Dumbrell, director of education, Bechuanaland Protectorate ; Mr. R. E. W. Flower, lately senior deputy keeper of manuscripts, British Museum ; Mr J. P. Bushe-Fox, chief inspector of ancient monuments, Ministry of Works ; Major J. Keith, chairman of the Board of Governors, North of Scotland College of Agriculture ; Mr. J. R. Learmonth, surgical director, Emergency Medical Services, S.E. Area of Scotland, and professor of surgery, University of Edinburgh ; Mr. R. C. Marshall, chief conservator of forests, Gold Coast ; Mr. W. L. Taylor, forestry commissioner ; Mr. R. R. Waterer, conservator of forests, Cyprus.

The Next 11-Year Solar Cycle Begins

THE recent appearance of a big sunspot (visible at times to the unaided eye), together with four or five smaller groups overlapping in time, probably signifies that the rise in solar activity towards its next maximum has now definitely begun This major group of spots in south latitude 22° crossed the sun's disk between December 8 and 20 last, the time of central meridian passage being December 14·3. A considerable disturbance in the earth's magnetic field occurred on December 16–17, with associated disturbed conditions for long-distance radio communication. For the past eighteen months, high latitude (20°–40°) sunspots have begun to appear in increasing numbers, giving the characteristic overlap seen at this epoch of the 11-year cycle with the decreasing old-cycle spots in equatorial latitudes (0°–10°). The routine observations of the magnetic fields of sunspots, carried out at the Mount Wilson Observatory (*Proc. Ast Soc Pacific*, Oct. 1944) show that the anticipated reversal of the magnetic polarity of comparable sunspots has taken place with the appearance of the new cycle spots, as first observed by Hale at the sunspot minimum of 1913. Sunspot frequency during 1943–44 gives a minimum at about 1944 5 The rise from minimum to the following peak of the cycle takes on the average 3½–4 years ; but individual cycles vary in amplitude and time of phase, not subject to prediction.

Earthquake in Britain

AN earth tremor approximately of scale 4½ on the modified Mercalli scale (scale 5—felt by nearly everyone, many awakened, some dishes, windows, etc , broken, a few instances of cracked plaster, unstable objects overturned ; disturbance of trees, poles and other tall objects sometimes noticed ; pendulum clocks may stop) in the epicentral region occurred on December 30, 1944, about 12.35 a.m. G.M.T. It was recorded on Mr. J. J. Shaw's seismograms at West Bromwich, and here the record lasted about two minutes The seismograph at Stonyhurst College Observatory was unhinged by the shock so that the full record was not obtained Reports are not yet to hand from other observatories. The tremor was felt by people over a radius of approximately a hundred miles, and was reported from Carlisle, Newcastle, Norfolk, Derby and intermediate places. No damage or casualties have been reported. So far as can be ascertained there was no noise associated with the tremor. In the north of England this was the greatest tremor since the North Sea earthquake (epicentre latitude 53·7° N., longitude 1·3° E) of June 7, 1931. A somewhat greater tremor shook Scotland and England on October 23, 1839, when the epicentre was near Comrie.

Mepacrine

AN important statement on the anti-malarial drug mepacrine B.P. (quinacrine hydrochloride of the United States Pharmacopoeia, also called 'atebrin' or 'atabrin') has been issued by the Medical Research Council's Committee on Malaria (*Brit. Med. J.*, 664, Nov. 18, 1944, and the *Lancet*, 667, Nov. 18, 1944). In view of the great importance of malaria in warfare in the Far East and the Mediterranean area, a

great deal of work has been done recently on the relative merits of the two chief anti-malarial drugs at present available, namely, mepacrine and quinine. Before the War the world's supply of quinine came almost entirely from Java, and, when the Japanese captured this island, they also cut off practically the whole supply of this essential drug. The Allied Nations turned, therefore, to mepacrine, originally made by the I G. Farbenindustrie, which announced its manufacture in 1932. Mepacrine has an acridine nucleus with a long side-chain ending in a substituted amino-group. It may stain the skin yellow when it has been taken by the mouth in large quantities. Its manufacturers stated that its anti-malarial action is as powerful as that of quinine, and this was confirmed during the Ceylon epidemic in 1935. One of the advantages claimed for it was that it is less likely than quinine to cause vomiting or to be followed by blackwater fever; but its action was said to be slower and, in a small proportion of cases, it was apt to cause symptoms resembling those of epilepsy or mania.

The relative merits of the two drugs have now been evaluated The United States Board for the Co-ordination of Malarial Studies has resolved, as the result of quantitative studies in civilian, Army and Navy establishments, that no advantage, and possible disadvantage, to the Armed Forces would follow if quinine or totaquine U.S.P. (which is a product containing cinchona alkaloids with an activity approximately equal to that of quinine) replaced mepacrine for the routine suppression and treatment of malaria; that the large-scale production of quinine or totaquine is not now important for the management of malaria in Army and Naval personnel, although increased supplies of totaquine may be required for civilians temporarily controlled by the Armed Forces; and that there will be, after the War, a continued great need for anti-malarial drugs The Medical Research Council's Committee on Malaria endorses these conclusions and agrees in general with the American views. This Committee says that mepacrine, under proper administration, is no more liable to cause toxic effects than is quinine, and that mepacrine is not an inferior substitute forced upon us by the Japanese occupation of Java; it is a more effective anti-malarial agent which would still be used if the supplies of quinine were unlimited

Child Health

THE City Council of Liverpool, together with the University and the Merseyside Voluntary Hospitals have combined to finance a chair of child health, which was opened on October 27 last (*Lancet*, 608, Nov. 4, 1944). This new department will teach the subject to undergraduates and, in postgraduate courses, to medical men. Liverpool thus follows the lead given by Edinburgh as long ago as 1931. The generosity of the Nuffield Foundation has made possible the creation of a chair of child health in London, where a postgraduate institute is to be created in association with the Hammersmith Postgraduate Medical School and the Great Ormond Street Hospital for Sick Children (*Brit. Med. J.*, 410, Sept. 23, 1944). The Nuffield Provincial Hospitals Trust has also assisted the endowment of a chair of child health at King's College, Newcastle-upon-Tyne.

It is clear that the children of the future are to be attended by medical men who have had more training in the diseases of children than practitioners now obtain. The health of their mothers is already the subject of much instruction and organization, and will also, it is to be hoped, be a prominent feature of medical work of the future The Children's Nutrition Council hopes to see, after the War, a campaign among housewives about foods and food-habits

Immigration in the British Commonwealth

A P E P broadsheet, "People for the Commonwealth" (No. 226), gives a review, with statistical appendix, of prospects for migration to the Dominions. The broadsheet concludes that the sparsely populated Dominions would benefit from a marked increase in population: their standard of living would thereby be higher and their military security buttressed Natural increase is bound to be slight, even if the decline in fertility in the Dominions can be checked and even if death-rates continue to fall. There is no alternative to immigration, and it has been estimated that Canada should have 50 instead of 11·5 million people, Australia 20 instead of 7 million, South Africa 5 instead of 2·5 million white people, New Zealand 5 instead of 1 5 million. In the past, non-British immigration has been rigidly restricted to safeguard the British character of the Dominions, which still want British emigrants. All the Dominion Governments are receiving applications from people who want to leave Britain; but such discrimination will in future be incompatible with a large volume of immigration, since there are not likely to be many British emigrants after the War, nor will there be many from the other nationalities which have traditionally been preferred. In the inter-war period, Britain assisted emigrants to the Dominions. If such assistance is once again given after the War and evokes substantial response, the imminent decline in British population will be hastened, and in view of its ageing population, Britain's own standards of living will thereby be prejudiced and the task of reversing the decline made more difficult. If immigration from Asia is excluded, the only remaining source will be the countries of southern and eastern Europe, and there is no reason for thinking that, given time and expansionist economies in the Dominions nationals of those countries could not be successfully absorbed.

Michigan Academy of Science, Arts and Letters

VOLUME 22 of the Michigan Academy of Science. Arts and Letters contains communications upon a wide range of subjects including, *inter alia*, forestry, geography, anthropology, history and philosophy (Papers of the Michigan Academy of Science, Arts and Letters Vol. 28 (1942). Pp. xiii+701+52 plates. Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1943. 28*s*. net). Most of the botanical papers deal with the determination of species in the lower plants. There is an ambitious and critical monograph on the *Leucopaxillus* (toadstools) by R Singer and A. H Smith, with chemical and microscopical data. Several papers deal with tropical marine Algæ, and a number of new Red Algæ are described G W. Prescott and A. M. Scott give about a hundred good line drawings of American forms of *Micrasterias* (a desmid), including many known in Britain and several new ones. Finally may be mentioned a charming little paper on the pollen of a Swedish bog by E. Janson and E. Halpert, who wondered whether the European facts could be as clear-cut as have been reported, but found they were so. The zoological papers deal with various topics from Arthropods to reptiles. It is known that

the common garter snake of North America can mate either in the autumn or in the spring. F. C. Blanchard has investigated the matter more fully and found evidence to show that effective mating occurs commonly in the autumn in the wild state. The offspring from such matings, if the females are kept isolated, exhibit normal Mendelian ratios in their colour pattern. In the wild, such females may copulate again in the spring and the resulting offspring show colour patterns that bear no relationship to any Mendelian ratio, and so it would appear that the actual insemination resulting from the autumn mating does not occur until after the spring mating. W. C. Beckman shows that in a number of game fishes in Michigan, temperature plays the leading part in the annulus formation in the scales. The mean temperature of the first days on which the majority of the scales showed an annulus is 58° F. An interesting paper by C. L. Hubbs and R. R. Miller deals with the influence of changed environment upon interspecific hybridization of two generations of Cyprinodont fishes

Quality Control Technique

A USEFUL booklet entitled "Quality Control Chart Technique when Manufacturing to a Specification", by B. P. Dudding and W J. Jennett, has recently been published by the General Electric Co., Ltd., of England (Research Laboratories, G.E.C., Wembley. 2*s*. 6*d*.). The booklet describes a more detailed development of the principles discussed in British Standard 600 *R* (1942), and the major aim of the technique described is to assist production to specification requirements with the elimination of waste labour and material While the handbook is intended principally as a guide for those concerned with the machine manufacture of articles to dimensional limits, it should be helpful to anyone introducing the technique for use in other types of manufacture. The book is arranged in two parts with appendixes. Part 1 deals with quantitative data and is concerned with the utilization of results of measurement. Part 2, giving qualitative data, is concerned with the utilization of the results of classifying a product into categories as, for example, 'defective' and 'effective'. Suggestions are made with the view of increasing the value of control charts for number defective in those cases where this method has to be adopted or it is preferred on grounds of convenience and/or cost.

Production Control in Industry

UNDER the title "Production Control in the Small Factory : Office Aid to the Factory" (B.S. 1100. Part 2 1944), the British Standards Institution has issued a booklet designed to advise on production control technique in the small factory. The need is stressed for control in order to make it possible economically to increase production and to eliminate waste of time and effort. The practice and procedure recommended are illustrated by taking as example a firm in which between fifty and sixty people are employed in the manufacture of jigs and fixtures for small assemblies. The number of schedules, records and documents is kept down to the minimum for simple control over issuing quotations, purchasing and stock, volume of work to be handled, flow of work to shops, production instructions, time-keeping and costs. The methods described are illustrated with specimen schedules, cards, record sheets, and a comprehensive order flow chart, which shows the various stages through which an order will pass. By careful study of these recommendations, factory managers should be able to adapt them to their firm's individual needs.

Lighting Reconstruction

THE Illuminating Engineering Society has now issued the fifth of the series of its Lighting Reconstruction Pamphlets, the present one dealing with city and highway public lighting. The pamphlet discusses what might well be done in the way of public lighting in the post-war period, and it offers useful guidance, with the view of achieving maximum benefit to those concerned. The pamphlets are obtainable from the Society at 32 Victoria Street, London, S.W.1, at the uniform price of 1*s*. each, 9*s* a dozen or £3 a 100.

Announcements

MR GEORGE SMITH, of the London School of Hygiene and Tropical Medicine, has been elected president of the British Mycological Society for 1945.

AT the meeting of the London Mathematical Society on January 25, at 3 0 p.m., in the rooms of the Royal Astronomical Society in Burlington House, Prof. J. Hadamard, of the Paris Academy of Sciences, will give his postponed lecture "Psychological and Personal Recollections of a Mathematician". Members of other scientific societies will be welcome.

A COMPREHENSIVE review of progress in industrial and medical radiology is contributed by Bernard John Leggett to the November issue of the *Journal of the Institution of Electrical Engineers* (91, Part 1, No. 47). The paper reviews atomic physics, the cyclotron and betatron, the generation of high voltage and design of high-voltage X-ray tubes, industrial radiology, medical radiology and bio-electric phenomena. A bibliography of sixty-seven items accompanies the paper.

AN Annotated Bibliography of Medical Mycology, edited by Dr S. P. Wiltshire, in collaboration with Dr. Charles Wilcocks and J. T. Duncan (Imperial Mycological Institute, Kew, Surrey, 1944. Pp. 32 5*s*.), lists all papers on medical mycology which were either published in 1943 or noted by abstracting journals during that year. Authors and subjects are indexed. Short summaries follow most of the headings If these summaries can be enlarged in future years, the value of this publication will be greatly enhanced The Bibliography can be recommended as a work of reference for dermatologists and pathologists.

CATALOGUE 63 of scientific books issued by Ifan Kyrle Fletcher. "Merridale", Caerleon, Mon., contains among others the following works of interest : Andrea Bacci's "De thermis libri system" (1571), Bateman's "Practical Synopsis on Cutaneous Diseases" (1824), first edition of Sir Thomas Browne's work (1686), Cheselden's "Anatomy of the Human Body" (1741), Cornaro's "Discourse on a Sober and Temperate Life" (1779), Fabricius ab Aquapendente's "Opera omnia anatomica et physiologica" (1687), John Freind's "Opera omnia" (1723), Sir John Harington's "Metamorphosis of Ajax" (1814), J. F. C. Hecker's "Epidemics of the Middle Ages" (1846), "Lunacy Acts" (1798–1824) and Mesué's "De re medica" (1542).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Existence of Time-dependence for Interfacial Tension of Solutions

IN a recent note under this title, Ward and Tordai[1] have pointed out that the interfacial tension between water and hexane solutions of lauric acid attains equilibrium at an anomalously slow rate, and suggest that this arises from a process of high activation energy being involved subsequent to the diffusion of solute molecules to the interface. The observed marked effect of temperature in hastening equilibrium was taken as support for this view.

Slow accumulation at an interface has been much discussed recently, and this further very interesting example would appear to be closely related to the slow ageing of surface tension of hydrocarbon solutions of dodecyl sulphonic acid[2]. A suggestion put forward to explain this latter phenomenon ascribed it to the slow breakdown at the surface of the strongly associated solute molecules[3], since on general grounds strong molecular association would be expected in such hydrocarbon media.

A somewhat similar picture may hold for the lauric acid/hexane system with its well-known monomer-dimer association. The polar groups in the dimer would be largely screened by the randomly kinked fatty-acid hydrocarbon chains, and on collision of the dimer with the interface could but seldom approach the aqueous phase sufficiently closely for interaction, and hence for the subsequent dissociation and re-orientation, to occur. As a first approximation, therefore, the dimer *per se* might be regarded as completely ineffective for bringing about equilibration. With the monomer, this particular restriction clearly would not exist, and the observed slow rate of equilibration would then arise from the small proportion of fatty acid existing in the monomeric state, which in hexane solutions would be expected to be very low indeed. (Even with the monomer a considerable proportion of the collisions with the surface would be ineffective owing to the large size of the hydrocarbon chain relative to that of the carboxyl group, but this can be estimated and is unlikely to be less than 10^{-2}.)

If this picture is correct, the time required for interfacial equilibrium should decrease with decreasing molecular association in the hydrocarbon medium. Accordingly solutions in nujol, in benzene and in nitrobenzene, of palmitic acid and of an oil-soluble detergent ('Aerosol OT', from the British Cyanamid Co.), have been studied, and the times for equilibration are found to decrease from several days with nujol to a few hours or minutes with nitrobenzene. No equilibrium constants for the association of fatty acids in nujol appear to be available, but it is certain that the extent of dissociation into monomer would increase in the above order[4].

The marked temperature coefficient observed is then readily explained as arising from the high ΔH value for the monomer-dimer association reaction, which is about 16·5 Cal. in the gas phase[5], greater than 9·7 Cal. in benzene[6], and about 6·0 Cal. in nitrobenzene[7].

This suggested explanation, if confirmed by further work, would provide another means of estimating the degree of association of polar compounds in hydrocarbon media, and hence of equilibrium constants and heats of association. It should be particularly useful for cases showing high association constants and for compounds insoluble in water, where the usual methods based upon freezing points, infra-red absorption spectra and distribution, are not suitable

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[6] Moelwyn-Hughes, *J. Chem. Soc.*, 850 (acetic acid).
[7] Private communication from Dr. M. M. Davies (propionic acid).

Photographic Fourier Synthesis

IN 1929, Sir Lawrence Bragg[1] showed that electron density projections and Patterson projections of crystal structures could be synthesized by the photographic addition of patterns of light and dark bands of proper period and orientation, one pattern for each term in the series. Later[2], I showed that such syntheses can be made easily and rapidly if one has available a set of suitable masks. These are inserted successively into a photographic enlarger and exposures made through them, the exposure times being proportional to the F or F^2 values of the coefficients of the individual terms in the series.

In making an electron density projection, the desired summation is

$$\sum_{hk} F_{hk0} \cos 2\pi (hx + ky),$$

where x and y are co-ordinates in the projected unit

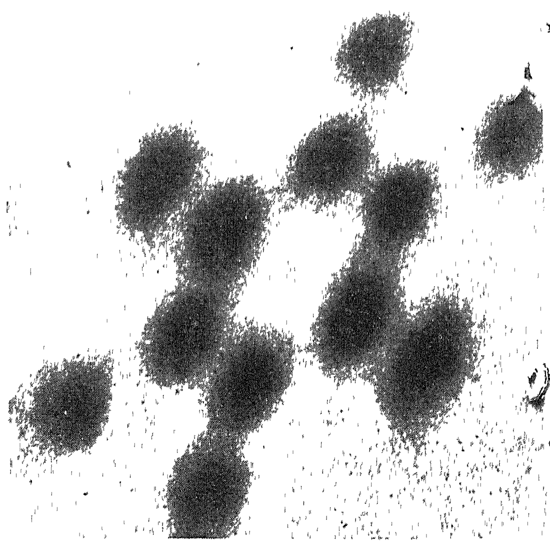
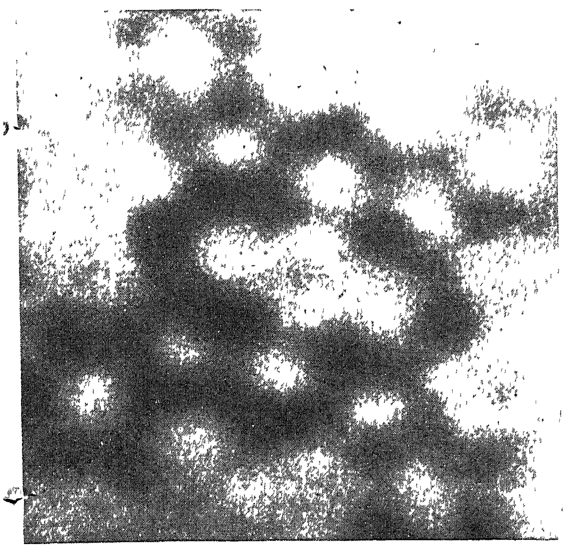


Fig. 1. PHOTOGRAPH OF A HEXAMETHYLBENZENE MOLECULE, OBTAINED BY PHOTOGRAPHIC FOURIER SYNTHESIS FOR X-RAY DATA BY BROCKWAY AND ROBERTSON[3]



10^{-8} cm

FIG 2 PHOTOGRAPH OF A PHTHALOCYANINE MOLECULE, FROM X-RAY DATA BY ROBERTSON[4]

cell. If the distribution of light transmission through each mask is

$$1 + \cos 2\pi\,(hx + ky),$$

the total light intensity reaching the photographic emulsion (on which the picture is being made) is the desired summation plus a uniform, unwanted background. The effect of this uniform background illumination can be nearly eliminated by using a photographic material—such as Velox F5, Kodalith paper or Kodalith film—with a suitable characteristic curve. Although not necessary for crystal structure analysis, the remaining background can be entirely removed by treatment with a reducer solution or by reprinting, using appropriate film and paper.

With the aid of the Physics Department of these Laboratories, an improved set of masks has recently been made, on a roll of 35 mm. film. Examples of syntheses obtained with these new masks are shown in the accompanying figures. In Fig. 1 the background has been partly removed by reprinting.

The departure from a perfect hexagonal structure in Fig. 1 is in part due to inclination of the molecule relative to the plane of the projection, and in part to the representation of the actual unit of the projection—a parallelogram with unequal sides and angles—by a square. In Fig. 2 these two factors practically cancel each other, the photograph showing the appearance of the phthalocyanine molecule with the line of vision normal to the plane of the molecule. If wanted, projections having the shape of the true unit can be produced by any of several procedures, now in process of being tested here.

We hope soon to be able to furnish copies of these masks, at a nominal cost, to others doing crystal structure work.

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Oct. 9.

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Grignard Compounds as Condensing Agents

IT is already known that Grignard compounds may act as reducing agents[1,2], or cause enolization of ketones[3,4], or bring about the condensation of esters of some fatty acids to β-keto-esters. The present communication records some observations on the condensation of ketones during the Grignard reaction.

It was observed during the preparation of some tertiary alcohols by reaction of alkylmagnesium halides with ketones that the product contained greater or smaller amounts of condensation product. Thus pinacolin (I) and *tert.*-butyl magnesium chloride gave as principal products, pinacolyl alcohol and a mixture of the hydroxy ketone (III) and the unsaturated ketone (II). None of the required alcohol could be isolated. Ethyl magnesium bromide also gave notable amounts of these condensation products, as did also phenyl magnesium bromide.

$$(CH_3)_3C\ CO.CH_3$$
(I)
$$(CH_3)_3C\ CO\ CH:C(CH_3).C(CH_3)_3$$
(II)
$$(CH_3)_3C.CO.CH_2.C(OH)(CH_3).C(CH_3)_3$$
(III)

A survey of the literature has shown that the formation of condensation products from ketones during Grignard reactions has been frequently recorded without any further characterization or identification[1]. Only two recorded examples of the identification of such products have so far come to our notice[2,5] It would now appear that the self-condensation of ketones during the Grignard reaction is more general than is commonly supposed, and that by selecting suitable reactants it may become the main reaction.

The experimental data at present available leads to the conclusion that alkyl magnesium halides with highly branched chains not only bring about reduction of the ketone but also promote condensation. The structure of the ketone is also an important factor; those with an available hydrogen adjacent to the carbonyl and a slow rate of reaction towards Grignard reagents condense more readily. If they react with Grignard reagents which do not cause reduction, such as the aryl magnesium halides, the formation of the condensation is still more favoured.

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Rates of Oxidation of Different Substrates in the Frog's Liver

IN the course of preliminary studies in an investigation regarding the mechanism of the regulation by hormones of enzymic processes, we have carried out determinations of the respiratory quotient (*RQ*) of the liver tissue with homogeneous material from the frog (*Rana temporaria*) in the summer state. For each specimen a determination of respiratory quotient was performed on slices by a modification[1] of the method of Meyerhof and Schmitt. The values obtained varied between 0·70 and 1·00. When the values of the oxygen consumption per mgm. fresh weight were

correlated with the corresponding values of the respiratory quotient, it was found that high values of the latter were accompanied by low oxygen consumptions and vice versa. It follows that different substrates occurring in the liver of the frog are oxidized at different rates.

A more detailed account of the results will shortly be published elsewhere.

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Effect of Anoxia on Excitation and Impulse Propagation in Isolated Motor Nerve Fibres

ALTHOUGH the paralysing action of anoxia on peripheral nerve has been frequently studied in previous investigations, so far as we know, no attempt has as yet been made to examine whether excitability and propagation of the nervous impulse react identically to lack of oxygen.

Monophasic action potentials of isolated motor nerve fibres (sciatic nerve of *Rana esculenta*) were used as indicators. The nerve was placed in a moist chamber consisting of two separate sections, one containing two platinum electrodes for stimulation with condenser discharges, the other two silver–silver chloride electrodes for leading-off action potentials. Care was taken to avoid stimulus escape and to provide constant resistance between the leading-off electrodes Anoxia was produced by passing a moist stream of purified oxygen-free hydrogen through each section of the chamber.

When anoxia is applied to both the stimulated and the conducting region of the nerve fibre, the average time necessary to suppress activity is 34 minutes, while it takes more than 70 minutes when anoxia is limited to the leading-off section of the chamber This difference is statistically highly significant. The action potential reappears immediately after readmission of oxygen with reduced amplitude and without a positive after-potential. After 15 minutes in oxygen it has regained its original shape and amplitude. The stimulated region of a peripheral nerve fibre is thus far more sensitive to anoxia than its purely conducting parts, a difference which might be of interest in the interpretation of the mechanisms of excitation and propagation.

A further discussion on the matter is to be published elsewhere.

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Toxicity of Adrenaline

UNHEATED solutions of adrenaline quickly acquire a coloration if exposed to air or oxygen for a short period of time. Sodium or potassium metabisulphite has been proposed as an antioxidant for such solutions[1], and the U.S. Pharmacopeia XII permits the use of reducing agents such as sodium bisulphite up to concentrations of 0·5 per cent. The effect of this substance on the toxicity of adrenaline was investigated in the United States[2], and an increase of more than 100 per cent subcutaneously and more than three times intramuscularly was shown when tests were made on mammals. But no reference was made to the toxicity of adrenaline solutions containing metabisulphite after heat treatment, for example, autoclaving. These heated solutions, provided the pH is adjusted, have already been found to have lost very little activity, and to be sterile and colourless[1].

Solutions of adrenaline (1/1,000) in hydrochloric acid, with a final pH of about 3 0, were therefore prepared with and without 0·1 per cent of potassium metabisulphite, and their toxicities were tested on rats and frogs. The solutions containing metabisulphite were divided into two parts, and one was put in an ampoule and heated at 115° C. for 30 minutes The rats were injected subcutaneously, the solutions containing 0 9 per cent sodium chloride, the frogs received their doses into the lymph sacs, the solutions containing 0 6 per cent sodium chloride. The approximate values for *LD* 50 (in mgm. per kgm.) were as follows: (*a*) rats—subcutaneously; adrenaline 12, adrenaline with metabisulphite 6, adrenaline with metabisulphite heated 14, (*b*) frogs—lymph sac; adrenaline 75, adrenaline with metabisulphite 30, adrenaline with metabisulphite heated 60.

Totals of sixty frogs (both sexes) and a hundred rats (all male) were used to obtain these values These are relatively small numbers, but the results are important and more detailed work is in progress. Metabisulphite more than doubled the toxicity of adrenaline, thus confirming previous results[2], but, on heating these solutions in 10-ml ampoules, the tendency was to return to the toxicity figures of the plain solution. Other experiments have been carried out using metabisulphite solutions (0·1 per cent in 0·9 per cent sodium chloride), heated adrenaline solutions, and heated metabisulphite solutions, but no significant results were obtained.

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Absolute Scotopic Sensitivity of the Eye in the Ultra-violet and in the Visible Spectrum

IN a paper published in 1941[1] measurements were given of scotopic and photopic sensitivity, for which nine observers were used. These measurements were made in the range between the mercury lines 709 and 302 mμ. In the paper by Goodeve, Lythgoe and Schneider published in 1942[2] measurements were given of scotopic sensitivity, for which six observers were used, including one with an aphakic eye. Their measurements were made at the mercury lines at 365 and 546 mμ. It is of interest to compare the results obtained after dark adaptation of one hour with the results of Goodeve *et al.*, obtained after dark adaptation for 10 minutes.

The absolute scotopic sensitivity, S_λ, in terms of (quanta/sec. sq. mm.) [1] is related to the illumination of the pupil, E_λ (the latter being expressed in terms of erg./sec. sq. cm.), by the equation

$$S_\lambda = \left[\frac{E_\lambda \times 10^{-2}(1-r)}{h\nu} \cdot \frac{\sigma}{a}\right]^{-1},$$

where r represents the reflexion losses at the cornea of the eye (assumed to be 0·05), σ the area of the pupil (assumed to be dark-adapted and equal to 50 mm.²), and a the area of the image on the retina in mm.². The area of the image a was 0·0088 mm.²

The accompanying table shows the comparison between our measurements of scotopic sensitivity and those of Goodeve *et al.*

	Observers and their age		log S_{365}		log S_{546}		log S_{546}/S_{365}	
	Pinegin	Goodeve *et al*	Pinegin	Goodeve *et al*	Pinegin	Goodeve *et al*	Pinegin	Goodeve *et al*
1st group	1 (17)	*A* (20)	−7 8	−7 5	−3 9	−4 1	+3 9	+3 4
	2 (19)	*E* (42)	−9 2	−9 8	−5 3	−5 0	+3 9	+4 8
	3 (15)	—	−8 4	—	−4 8	—	+3 6	—
	4 (19)	*B* (27)	−8 7	−8 8	—	−4 3	—	+4 5
2nd group	5 (37)	*D* (34)	−8 3	−8 3	−4 9	−4 4	+3 4	+3 9
	6 (22)	*C* (27)	−7 7	−7 7	−3 8	−4 2	+3 9	+3 5
	7 (25)	—	−8 6	—	−5 0	—	+3 6	—
	8 (21)	—	−7 9	—	−4 9	—	+3 0	—
	9 (29)	—	−7 8	—	−5 1	—	+2 7	—
	Mean values		−8 5	−9 2	−4 9	−4 5	+3 6	+4 7
		Mean values without *E*	—	−8 3	—	−4 3	—	+4 0
	Mean values for the first group	—	−8 8	—	−5 0	—	+3 8	—
	Mean values for the second group	—	−8 3	—	−4 8	—	+3 5	—
	—	*F* (26) (aphakic)	—	−4 2	—	−4 2	—	0 0

The absolute scotopic sensitivity in the ultra-violet was found to have greater individual variations, as some of the observers have maximum sensitivity at 334 mμ, and others have a flattening of the curve at 334–365 mμ. The value S_{365} for most observers in my investigations and in those by Goodeve *et al.* varies approximately in the same limits. Two of the observers in both cases have an equal sensitivity. But the mean value of S_{365} according to Goodeve *et al.* is considerably lower than the same value for the first and second group or for all the observers, in my case. If we exclude the data given by these authors for the eye with the lowest sensitivity, the mean value of S_{365} will be nearly the same for all my observers and equal to the mean value for the second group.

The mean value of S_{546}, according to Goodeve *et al.*, is 2·5 times my value. Therefore the threshold retinal illumination according to these authors was about 35,000, while according to my measurements it was about 85,000 quanta/sec. sq. mm.

This divergency can be explained by the difference in the area of the image on the retina (0·0088 mm.² in my case and 0·42 mm.² in the case of Goodeve *et al.*). Therefore the value of S_{546}, according to Gassovsky, Khokhlova and Bourago[3], must, in the case considered by Goodeve *et al.*, be twelve times my value. A considerable difference in adaptation could compensate for this divergency (up to 2·5 times). As a result, the mean value of the ratio S_{546}/S_{365} in our experiments was equal to 4,000, while in those by Goodeve *et al.* (excluding the observer with the lowest sensitivity) it was 10,000.

Thus the measurements of the scotopic sensitivity of the normal eye in the ultra-violet and in the visible spectrum, obtained by these authors, are in agreement with my results and fully confirm the latter.

The absolute scotopic sensitivity of the aphakic eye, according to Goodeve *et al.*, as could have been expected, was found to be the same at 365 mμ as at 546 mμ. This fact, in particular, confirms the measurements of the light fluctuation, made by S. I. Vavilov, including the presence of a maximum of retinal sensitivity at 3800 A [4-11].

Goodeve *et al* consider 309 mμ as the limit of vision of the normal eye and 298 mμ as that of an aphakic eye. Nevertheless, even at 302 mμ I was able to carry out the measurement not only of the scotopic, but also of the photopic, sensitivity of the normal eye.

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U S.S.R.

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Large Contact Angles of Plant and Animal Surfaces

THE large values given by Fogg[1] for the contact angles of water with leaves suggest that these are apparent rather than true contact angles. Adam[2] and Wenzel[3] have shown that rough surfaces give an apparent contact angle which is greater than the true contact angle for the smooth material of the surface when the true contact angle is greater than 90°. We have recently extended this theory to porous surfaces[4], and to surfaces so rough that much air is entrapped at the interface between the water and the solid; large apparent contact angles are then possible when the true contact angle is even less than 90°. The apparent contact angle is given by

$$\cos \theta_D = f_1 \cos \theta - f_2, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where θ_D is the apparent or observed contact angle, θ is the true angle, f_1 is the area of solid – water contact and f_2 is the area of air – water contact per unit superficial area of the interface.

The exposed surface of ducks' feathers has a ratio for f_2 to f_1 of around 5, and although the advancing contact angle for the material of the feather is no more than 90°, and the receding one 65°, the apparent angles are both around 150° because of the large value of $f_2 : f_1$. Thus, 'water always runs off a duck's back' because of the structure of the feather rather than because of an exceptional proofing agent.

The mirror-like reflexion of raindrops on leaves, particularly noticeable with broccoli leaves, must be due to total reflexion at an air layer between the

water and the continuous surface of the leaf. The degree of perfection of the mirror indicates that here, too, the ratio of f_2 to f_1 must be great, and the values of the observed contact angles will be largely determined by this ratio. The diurnal and wilting variations observed by Fogg are therefore more likely to be due to changes in the physical structure of the leaf cuticle with its water content than to changes in the material of the cuticle

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Presence in Raw Cow's Milk of a Bactericidal Substance Specific for Certain Strains of Coliform Organisms

DURING the course of an investigation as to the reason why certain strains of coliform organisms when inoculated into raw 'sterile' milk did not reduce methylene blue or resazurin, it was found that these organisms were actually destroyed in milk held at 37° C. for six hours[1]. As all the tests for the presence of a bacteriophage in the raw milk were negative, it was considered that the destruction of the organisms might be due to a specific bactericidal substance in the milk. The destruction of the organisms appeared to be closely correlated with the temperature at which the milk was held, so it was considered that the substance was probably not thermostable and further work was undertaken to find out the effect of heat on the substance. To do this, 'sterile' raw milk which had been heated to temperatures varying from 52° to 53° C. for half an hour was inoculated with young broth cultures of the susceptible strains of coliform organisms, so as to give an approximate inoculation count on MacConkey's agar of 500,000–2,000,000 organisms per ml.

Plate counts on MacConkey's agar were carried out at inoculation, and after holding the inoculated milk in a water-bath at 37° C. for four hours, with the following results:

	Temperature to which milk was heated (for half an hour) before inoculation	Count per ml at inoculation	Count per ml after 4 hours at 37° C.
Culture No. 1	52° C	1,328,000	1,000
	53° C	848,000	40,000,000
Culture No 2	52° C.	316,000	31,000
	53° C.	640,000	28,000,000

From these results it would appear that the bactericidal substance is completely destroyed by heating to 53° C. for half an hour, and that this destruction is critical to within 1° C.

All the cultures of susceptible coliform organisms were originally obtained from raw milk which the presumptive coliform test showed to contain coliform organisms in 1/1,000 ml. but which did not reduce methylene blue or resazurin after six hours incubation at 37° C.

The organisms were tested by the recognized differential tests to find if they conformed to any particular type, and the results of these tests showed that the majority of the organisms were intermediate types.

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'Marsh Spot' in Beans

THE condition known as 'marsh spot' in peas has been proved by Piper[1], using water cultures, to be due to manganese deficiency. An analogous condition in two varieties of broad beans (Wooster Mammoth and Jarvis) used for seed has been observed in the field in the United States by Orton and Henry[2], who suggested that it resembled 'marsh spot' in peas, and by Furneaux and Glasscock[3] in broad beans grown for seed on Romney Marsh. Similar symptoms in runner bean seeds submitted by a seed-firm have been reported by Pethybridge[4], who suggested manganese deficiency as a possible cause, and by De Bruijn[5] at the Dutch Seed Testing Station in crops grown for seed.

During 1944, peas, *Pisum sativum* (var. Duplex), broad beans, *Vicia Faba* (var. Exhibition Longpod), runner beans, *Phaseolus multiflorus* (var. Scarlet Emperor) and French (dwarf) beans, *Phaseolus vulgaris* (var. Masterpiece), were grown at Long Ashton in manganese-deficient sand cultures, using a refined pot-culture technique, and the pods left on the plants until dry before harvesting. Examination of the seeds revealed typical severe 'marsh spot' in the peas, and mild to severe stages of a 'marsh spot' type of symptom in broad beans and runner beans, as illustrated; the middle of each cotyledon was sunken, brown and pithy, and the embryo in beans frequently showed browning of the plumule as noted by De Bruijn[5] in peas. The dwarf beans remained free from any signs of 'marsh spot'.

Typical leaf symptoms[6] (pale green, resembling a low nitrogen condition, with some faintly chlorotic mottling in runner beans and a more marked chlorotic mottling followed by severe intervenal necrosis and withering in dwarf bean) were developed, and

TYPICAL MARSH SPOT SYMPTOMS IN (ABOVE) RUNNER BEANS, (MIDDLE) BROAD BEANS, AND (BELOW) PEAS

numerous pods failed to fill after setting. Broad beans, as with peas, normally show only a faint intervenal chlorosis of the leaves and the symptoms are not striking.

In a field trial in 1943, peas and broad beans (var. Exhibition Longpod) growing in an acutely manganese-deficient market garden soil in Bristol were examined and showed symptoms of the 'marsh spot' type in stages ranging from mild to severe. Similar material examined in 1944 showed severe 'marsh spot' in the peas and only mild symptoms of this trouble in the beans Runner beans (Scarlet Emperor), dwarf beans (Prince and Masterpiece), a haricot bean (Comtesse de Chambord) and a tick bean included in the trial showed no symptoms in the cotyledons. The typical leaf symptoms were especially severe in the dwarf beans and in the haricot beans, in which the symptoms resemble those of the dwarf bean.

Leaf symptoms in these trials have been prevented and cured by spraying the leaves with an aqueous solution of manganous sulphate (0·25 per cent solution of $MnSO_4.4H_2O$). The results show that whereas peas are very susceptible to manganese deficiency, as shown by the severity of 'marsh spot', broad and runner beans are more resistant to this form of injury, whereas dwarf beans and haricot beans, which show the most marked leaf symptoms, are most resistant and may remain free from 'marsh spot' even when the leaf symptoms are very severe

Some details of this and related work carried out under the Agricultural Research Council scheme for plant nutrition have already appeared, and a further report is in course of preparation[7].

I wish to make acknowledgments to the Agricultural Research Council for permission to publish this note and to Mr. G. H. Jones for taking the photograph.

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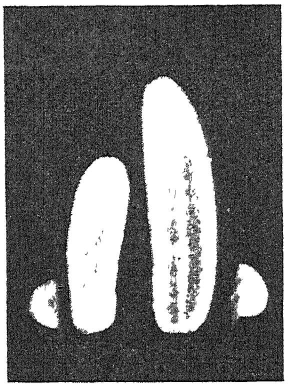
Fluorescein-induced Parthenocarpy

PARTHENOCARPY can be induced in, among other plants, the common edible members of Solanaceæ and Cucurbitaceæ by artificial treatment of the unfertilized ovary with pollens of a different family[1], pollen extracts[2,3], many growth-promoting substances like indole-acetic acid[3,4], and even manganese salts[5]. All the inducing agents so far employed, including manganese salts, have been shown either to contain auxin or to be auxin-like in their physiological activities. These facts have led to the hypothesis proposed by Gustafson[3] that growth hormones are essential for the initiation and maintenance of fruit development, and recent experimental evidence seems to support this view[5]. While there is no doubt that growth hormones, defined as they are, play a dominant part in fruit development, it is still a question whether auxins or auxin-like substances alone can induce parthenocarpy; for we have been able to induce parthenocarpy in members of these two families with fluorescein, a substance known to act on plants sometimes antagonistically to auxins.



Left: PARTHENOCARPIC FRUIT
Right NORMAL CUCUMBER

During our investigations on the physiological activities of fluorescein dyes, we had applied a lanolin paste of 1 per cent fluorescein to stigma and cut styles of protected female flowers of cucumber. About half the treated pistils eventually developed into fruits which answered all the descriptions of parthenocarpy, being a little smaller in size and with a relatively large fleshy pericarp and empty ovules (see accompanying photograph) Similar smaller and seedless parthenocarpic fruits have been induced in *Luffa*, egg plant and pepper in subsequent trials. Time, however, does not permit a detailed study.

It has been known that roots which have been treated with eosin, one of the fluorescein dyes, lose their geotropic sensitivity and acquire phototropism instead[7]. This action of eosin has been explained by Skoog[8], who showed that traces of eosin cause rapid photodynamic inactivation of solutions of indole-acetic acid. When fluorescein was fed to plants at regular intervals, Seller[9] was able to show that fluorescein at certain concentrations (0·5–3 per cent) dwarfs the plant, but at lower concentrations (1 : 2,000,000) promotes its growth and general development. The concentration we used for inducing parthenocarpy far exceeds those which will have beneficial effects on plants. Fluorescein is neutral in the *Avena* test and fails to induce local swelling in decapitated epicotyls of *Vicia*, as auxins and, strangely enough, some of the very common chemicals (for example, sugar) would do. Since Muir[6] has shown that the initiation of fruit development by pollen may be an indirect one, growth hormones being liberated from inactive combinations in the ovary after the pollen tube has been introduced, fluorescein dyes might do the same. We have in mind an analogous case in animal embryology, when certain dyes may uncover the inducing power of an embryonic tissue[10]. The plant used in our experiments is well known for its tendency to yield parthenocarpic fruits. It would be of great interest if similar experiments on parthenocarpy can be extended to other dyes, chemicals and even mechanical treatment.

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Linear Intercepts, Areas and Volumes

IN recent correspondence, Mr P. A. P. Moran[1] has suggested a simple method of finding the surface area of small objects from their average area of projection. Another simple method of finding the surface area and also the volume of small objects is based on the measurement of their average linear intercept (mean chord). Some years ago, while working on the determination of the grain-size of rocks, I derived two formulæ and discovered two theorems related to the average linear intercepts. The formulæ can be applied to the calculation of the average grain-size in granular aggregates in which the sizes and the shapes of grains are the same. The theorems, so far as I can see, have a purely academic interest, although their application to granular aggregates may be attempted.

Enlarging on the conclusions arrived at by M. W. Crofton[2] for convex figures, the two formulæ are derived as follows: (1) In a plane convex figure (polygon, circle) the average length of projection is equal to the perimeter divided by π, and the average linear intercept (l) is equal to the area divided by the average length of projection:

$$l = \frac{\pi \times \text{area}}{\text{perimeter}}$$

(2) In a three-dimensional convex figure (polyhedron, sphere) the average area of projection is equal to the surface area divided by four, and the average linear intercept is equal to the volume divided by the average area of projection:

$$l = \frac{4 \times \text{volume}}{\text{surface area}}.$$

As particular cases of these formulæ we have the following theorems:

1. The average linear intercept of a convex polygon circumscribed by a circle is equal to the average linear intercept of the circle.
2. The average linear intercept of a convex polyhedron circumscribed by a sphere is equal to the average linear intercept of the sphere.

In conclusion I would like to express my thanks to Dr. H. P. Mulholland and Dr. G. R. Goldsbrough, for their help in this matter.

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Amplitude Effect in Cepheid Variables

IN the interesting review[1] of the pulsation theory in his George Darwin Lecture of 1943 before the Royal Astronomical Society, Prof. S. Rosseland has indicated the importance of unharmonic oscillations in explaining the Cepheid characteristics, and brought out the effect of the amplitude in lengthening the pulsational period, pointed out by Kluyver[2] in 1937, and imparting the characteristic skewness to the light and velocity curve.

In the special case, when the amplitude is of the order of a fourth of the radius, the star being composed of a homogeneous monatomic gas, on neglecting the overtone effect, and taking account of the self-coupling term for the fundamental up to the third order only, Prof. Rosseland mentions a lengthening of period in the ratio 1·7 : 1, and a rise to the maximum four times faster than the decline to the minimum. While there is a considerable discrepancy to be bridged, these results should be taken as good indication of the amplitude effect.

For general values of the adiabatic index, it is, of course, imperative to take resort to approximations, even with a predominant self-coupling term; but for homogeneous monatomic gases, a complete solution for the fundamental can be obtained. One of the integrals of motion, since the time is not explicitly present in the Hamiltonian, is

$$H = K + U + V = \text{const.},$$

K, U, V being the kinetic, thermal and potential energy of the star. Neglecting the overtone velocity term in K, and the inter-coupling terms in U and V, the equation for the time coefficient can be solved without approximation, and it is found that assuming η to be the proportionate amplitude of pulsation, the time coefficient varies between the limits 1 and $(1 + 2\eta)^{-1}$. For $\eta = 1/3$, this gives 1 and $-0·6$; the corresponding values given by the third order approximation are 1 and $-0·5$. This is close enough, but at the same time the value $-0·6$ indicates a further increase in the discrepancy with the observed values.

The pulsational period in terms of that for the harmonic period is $\dfrac{T_{\text{anharmonic}}}{T_{\text{harmonic}}} = \dfrac{(1+\eta)^3}{(1+2\eta)^{3/2}}$,

while the speed of increase of the velocity curve to maximum over the decline to the minimum is given by the ratio

$$\frac{\text{Time of decline}}{\text{Time of rise}} = \frac{\pi - \cos^{-1}\left(\dfrac{\eta}{(1+\eta)}\right) + \dfrac{\eta\sqrt{1+2\eta}}{(1+\eta)^2}}{\cos^{-1}\left(\dfrac{\eta}{1+\eta}\right) - \dfrac{\eta\sqrt{1+2\eta}}{(1+\eta)^2}}$$

These give a steady lengthening of the period from the value for the harmonic oscillation to a value 1·56 times as great. The skewness of the velocity curve increases as η varies from 0 to 1; during this time the speed ratio increases only from 1 to 4·12. For $\eta = \frac{1}{3}$ these ratios are 1·20 and 1·92, while Prof. Rosseland's values are 1·70 and 4 approximately. The details of the calculations will be given elsewhere.

Thus the fitting to the observed values achieved for the rather large value $\eta = \frac{1}{3}$ even vanishes, and the discrepancy which Prof. Rosseland rightly points out appears to be considerably greater than he thinks. For values of η of the order of the observed values, the anharmonic oscillation curves would be almost indistinguishable from the harmonic case.

We therefore think that the amplitude effect is a contributory cause to the Cepheid characteristics, and probably not a dominant cause; and factors such as the decrease in the central condensation[3,4] must be brought in for a complete explanation of the Cepheid phenomenon.

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ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

ANNUAL CONFERENCE

THE nineteenth annual conference of the Association of Special Libraries and Information Bureaux, held in the rooms of the Royal Society on December 9 and 10, 1944, was one of the best attended conferences of the Association, and most of the sessions were characterized by animated discussions which indicated a live interest on the part of the general body of members

In his opening presidential address, on "Organized Knowledge in the World of the Future", Sir Frederic Kenyon, after congratulating the Association on its achievements, said that the *raison d'être* of ASLIB is the service of humanity by the organized supply of knowledge. While the service of industry is its first and most obvious activity, he believes that knowledge must not be restricted to such utilitarian application but applied in the most liberal spirit to the whole of our national life. We cannot rest satisfied with the lack of appreciation of the knowledge, the skill and the inventiveness to be found in British science and scholarship and with the failure to apply them. The practical value of scientific research can no longer be denied and Sir Frederic hopes that we shall not grudge expenditure on free disinterested studies. While, however, it is right that we should try to make this knowledge readily available for those who are able to use it, that alone is not enough. Knowledge can be curse as well as blessing, and Sir Frederic urged that knowledge must be not merely organized but also its use controlled by principles of higher validity than material power. Knowledge is good, but its value is related to something higher still which Plato called the idea of good, and which Bacon called God. Sir Frederic believes that the welfare of the nation and of the world at large depends on a change of soul and a change of living, which can only be effected by a change of principle from competition to co-operation, from organization to morality or religion. The organization of knowledge must be harnessed to moral standards if strength and wisdom are to be brought together.

The first session of the Conference was devoted to a particular aspect of this co-operation, "The Empire Contribution to the Flow of World Information", and Prof. R. S. Hutton presided. As a basis for discussion, members of the Conference had before them nine papers describing various specialized sources of information on and within the British Empire; those of Mr. R. L. Sheppard, Mr. Kenneth Binns, Mr. G. B. Gresford and Mr. A. L. Poole were presented in person. Some notes on the India House Library were also available at the Conference. Sir Harry Lindsay described the work of the Imperial Institute as a special library and information bureau. Sir David Chadwick outlined the work of the twelve Imperial Agricultural Bureaux. Mr. Sheppard described the development and work of the Bureau of Hygiene and Tropical Diseases from the Sleeping Sickness Bureau which commenced work on June 1, 1908, in a room at the Royal Society. The Bureau is now responsible for the issue of the *Tropical Diseases Bulletin*, the *Bulletin of Hygiene* and the *Bulletin of War Medicine*, and surveys for this purpose some 650 English and foreign medical and scientific periodicals. The abstracting is done by a panel of more than two hundred contributors specially associated with the subjects they review, and Mr. Sheppard emphasized the critical character of the abstracts issued.

A note on the Library of the Royal Empire Society in 1944 was contributed by Mr. Evans Lewin, who described its work more fully at the 1933 Conference The note included a select list of periodical publications received in the Library; and a list of sources of Canadian bibliographical information was forwarded by Mr. C R. Sanderson, chief librarian of the Public Library of Toronto, among which the Canadian catalogue of books published in Canada, about Canada, as well as those written by Canadians, was singled out for mention by Prof. Hutton This has been published annually since 1923 by the Toronto Public Libraries.

The flow of information between Britain and Australia was discussed by Mr. Binns, who stated that a second edition of "Pitt's Catalogue of the Scientific and Technical Periodicals in the Libraries of Australia" is in preparation, and that a similar work on the social sciences is planned by the National Library. The National Library has also issued annually, since 1936, a fairly complete list of publications appearing in the Commonwealth or touching Australia; and this, and a Select List of Representative Works dealing with Australia, issued annually since 1934, has been freely available to overseas libraries and institutions on an exchange basis. The Australian National Research Council also publishes *Australian Science Abstracts*; but in reply to a question, Mr. Binns admitted that this has a very limited circulation. He also referred to the establishment this year at Australia House, London, of an Australian Library of Information as an activity of the National Library at Canberra. A further paper, "Notes on Library and Information Services in Australia", presented by Mr. G. B. Gresford, emphasized the value of "Pitt's Catalogue of Scientific and Technical Periodicals in Australian Libraries", and also referred to the Scientific Liaison Bureau set up in 1942 by the Commonwealth Government and to the Information Section maintained by the Council for Scientific and Industrial Research. In concluding, he referred to the two schools of thought in Australia with regard to the publication of scientific research, and invited opinion as to the desirability or otherwise of publication in Australian periodicals or overseas. In response to this invitation, it was urged during the discussion that a policy of publication in the established British and American periodicals, such as the *Journal of the Chemical Society* and the *Journal of the American Chemical Society*, should be followed, and efforts made to avoid the multiplication of periodicals the circulation of which could only be limited.

In a further paper, Mr. A. L. Poole contributed some notes on the organization of scientific research in New Zealand with a list of sources of bibliographical information on New Zealand, while the final paper in the symposium, communicated by Mr. P. Freer, on "Bibliographical Work in South Africa", in addition to enumerating the chief guides to recent literature of the Union, made a number of suggestions for improvement of co-operation, some of which were taken up in the ensuing discussion. Among these suggestions were the improvement of book supply centres in South Africa, possibly inter-allied book centres in co-operation with the British Council,

co-operative cataloguing, reprinting of important books now out of print and the exchange of staff between the National Central Library and the Dominion State libraries. Very little tangible result emerged from the discussion, though there was clearly support in general for further co-operation in various directions, including abstracting, between English-speaking countries. No evidence was supplied that much progress has been made as yet on the lines indicated in the report of the British Commonwealth Science Committee, but some reference was made to Dr. Needham's more recent proposals (see *Nature*, November 25, pp. 649, 657).

The second session of the Conference was devoted to a paper on "Trade Catalogues in the Commercial Library", by Mr. G. K. Wilkie, who briefly described the collection of such catalogues in the Leicester Municipal Libraries, indicating its value as a source of technical information, the way in which the collection was formed and the method of making it available to the public He favours the vertical file system of housing, and stressed the importance of having the right person in charge of any such collection.

Past conferences of the Association have frequently suffered from the attempt to cram two papers into a session barely adequate for the discussion of one, and of this the third session was an unhappy example. Mr. E. Carter's able chairmanship could not avoid an untimely termination of the discussions stimulated by Mr. G. A. Shires' paper, "The Technical Information Bulletin and what to put in it", and Mrs. Moholy's report on microfilm developments. Mr. Shires outlined the general policy on which the service offered was based, as shown in the issue of such a bulletin in the Dunlop Rubber Company. He aroused lively curiosity as to the means by which he secured the efficient production of abstracts from specialist members of the technical staff; but only the barest discussion of the material aspect or of the principles followed in the selection and presentation of material was possible. Mrs. Lucia Moholy presented her report on "Developments and Extensions in the Uses of Microfilm". This paper covered the period since her report to the Association's Conference in November 1942. The day-to-day activities of the ASLIB microfilm service include the recording in detail of every strip of film of which a master negative is retained, catalogue entries with all available particulars which serve as a basis for the acquisition of new items, and the development of special filing arrangements. Co-operation with Government departments and special libraries has enabled the service to be extended far beyond the original scope of a technical unit. Dr. Moholy visualizes two main tasks for documentary reproduction in the projects of an international clearing house of library services and for scientific co-operation: the interchange of complete books, periodicals and other publications on microfilm, and the supply of articles from periodicals, excerpts from books and other selected items for specialized research on film strips, in microprint or photostat copies as required. Documentary reproduction would be of special importance in co-operation with an international research service as a technical section covering all branches of learning—the sciences and the humanities.

An adequate supply of reading machines is still lacking, and Dr. Moholy does not think that the failure to meet the demand can be justified merely by war-time difficulties. First-class microfilm readers are still manufactured in the United States; but the supply is restricted to those who can obtain the necessary permits and high priority. Recently, a microfilm viewer has been designed in the United States for a special purpose. This reader, which was exhibited at the Conference, folds into a flat box 5 in. by 2 in. and weighs less than 2 oz. It is useful for looking up references and may in emergency serve for reading a few pages, but is not suited for research purposes. Reference was also made to the recommendations on filing and storing microfilm issued this year by the British Standards Institution (B.S. 1153—1944), and to the possibilities of microprint as recently emphasized by Fremont Rider in his book "The Scholar and the Future of the Research Library" (see *Nature*, November 25, p. 655). Mrs. Moholy pointed out that microprint is only justifiable for a considerable number of copies and is thus on an equal footing with printed matter and subject to copyright. If the technique of microprinting is adopted in Great Britain, a similar or supplementary agreement like the draft agreement on microfilm issued by the Publishers' Association in co-operation with the Society of Authors, and in consultation with the Association of Special Libraries and Information Bureaux, and published in the *Bookseller* of July 7, 1944, would be required. Mrs. Moholy's report, and the subsequent discussion, indicated a more sober view of microfilm and of its limitations than formerly prevailed, and that it must be regarded as supplementary, not replacing, other means, such as photostats.

The next session of the Conference, over which Mr. C. le Maistre presided, considered a paper by Mr. E. R. McColvin on "The Education and Status of Special Librarians", which was based on the answers to a questionnaire circulated to members of the Association, chiefly on the replies received from research organizations, industrial or commercial organizations and Government departments. Mr. McColvin emphasized that organization would be better and more efficient the fewer the dead-end positions at any level to be found in it. His analysis of the requirements of both junior and senior staff led him to outline syllabuses suggested by the ASLIB Education Committee. This paper was followed by one by Miss Ruth S. Leonard on the recruitment and training of special librarians to fit the present and future needs of the special library profession in the United States. Throughout the animated discussion on these two papers, there was a pronounced cleavage of opinion, as was also evident in the voting on a resolution in favour of the question being taken up by the Association. It is difficult to see that any substantial advance has been made since the question was last debated at the Association's Conference of 1935.

At the final session, when Sir Hugh Beaver presided, Mr. A. B. Agard Evans presented a paper on "Some Aspects of a new Technical Information Service in War-time", in which he discussed such problems against the background of the experience of the Records Section of the Research and Experiments Department of the Ministry of Home Security. This Records Section was part of the initial organization of the Department which came into being in February 1939 under the chief adviser, Dr. R. E. Stradling, then director of building research under the Department of Scientific and Industrial Research. Collaboration of the records officers of the three Service departments, other Government departments and of technical institutions was secured, and the

A.R.P. Department and the Building Research Station in particular provided a valuable nucleus of technical information, and the Civil Defence Research Committee established in May 1939 was a further focus Mr. Evans also referred to the generous help of the Patent Office Library, the Science Museum Library, the British Library of Political and Economic Science and the Royal Institute of British Architects. To the main subjects originally covered, such as H.E. and incendiary bombs, blast, ballistics, fragmentation and penetration, building and strength of materials, were soon added others such as lighting and black-out, physiological and psychological effects, camouflage and paint, window protection, location of industry and population. In regard to shelving, Mr. Evans stated that, as in other stations of the Department of Scientific and Industrial Research, books are shelved under broad subject headings, pamphlets by country and institution, periodicals alphabetically by title In regard to book buying, he suggested that it would be of great value to librarians if publishers would set up a joint central library of new technical books where they could be inspected with the view of purchasing through the usual channels Mr. Evans also commented on the limitations of microfilm, and appeared to lean rather to a photostat, urging strongly the termination of the system of loaning heavy bound periodicals and substituting a photostat or microfilm copy of the article required.

STUDIES OF THE AMARYLLIDACEÆ

HERBERTIA, the year-book of the American Amaryllis Society, has now reached its tenth volume (from L. S. Hannibal, Concord, California, July 1944). This publication maintains its potent blend of science with practice. It employs fertility in number of its titles with economical expression in its individual papers, to achieve a wide review of all questions which affect the horticulture of Amaryllids. Many facets are discussed—personal, historical, and cultural. In the sections on classification, genetics, the physiology of reproduction, and pathology, several interesting facts appear.

Dr. Hamilton P. Traub, editor of *Herbertia*, has published an account of the tribe Brunsvigieæ, which, it is proposed, should now include the genera *Crinum*, *Brunsvigia*, *Buphone*, *Nerine*, *Ammocharis* and *Cybistetes*. A new genus, *Worsleya*, has been proposed to separate the single species *W. procera* from the genus *Amaryllis*, with which it has no gene exchange, and from which it differs in several morphological characters. The genera *Agapanthus* and *Tulbaghia* are border-line genera between Amaryllidaceæ and Liliaceæ, now included in the former group. J. C. Th. Uphof reviews the present position of the two genera, and describes the species included in each. As a background for taxonomic studies, W. S. Flory, jun., reports the chromosome numbers for various species of Hemerocallideæ, Alstroemeriales and Amaryllidales which have been published since his earlier review in 1937.

Gardeners and students will be interested in a brief article by Kenyon L. Reynolds outlining the method for cross-pollinating Narcissi. This involves the ripening of pollen in a desiccator. V. T. Stoutemyer and Albert Close also discuss the latter question, suggesting the trial of freezing temperatures and definite humidities for storing pollen, and the use of mixed pollen, hormones, and other substances for overcoming certain types of sterility. Their paper is, however, a wider review of the whole question of reproduction. Many seeds of Amaryllids germinate without a rest period, while others have a more or less protracted time of dormancy. Seeds of *Hymenocallis occidentalis* have an integument capable of photosynthesis, which appears to accelerate germination, though development can take place more slowly in the dark. It is interesting to note that vegetative propagation by scoring or cutting the base of the bulb is being employed more extensively in the Amaryllidaceæ. John V. Watkins adds a further note on the use of this method for *Lycoris aurea*.

L. S. Hannibal records the lesser bulb fly as a pest on several Amaryllids other than Narcissus. *Lycoris squamigera* and *Hæmanthus multiflora* appear to be even more heavily attacked than members of the genus *Narcissus*.

The natural order under discussion, however, seems to have but little acquaintance with pest or disease, and this factor should be added to that of superb garden beauty to inspire an even wider horticultural use of this interesting group.

NEW WOODS FOR CROSS-ARMS FOR TELEGRAPH LINES

AN article by G. Q. Lumsden (*Bell Lab. Rec.*, 22, No. 14 , October 1944) discusses new woods for cross-arms and their preservation. Since the turn of the century, the open-wire lines of the Bell System (U.S.A.) have been carried mostly on Douglas fir and southern pine cross-arms. War emergency demands for these timbers have made it necessary, however, to seek substitutes, and the woods most readily available were red and jack pine from the Lake States and the inland type of Douglas fir from the north-west.

In testing out these alternatives it was decided to apply a preservative treatment to the new arms by an improved hot-and-cold bath process, instead of using the standard pressure processes regularly employed for southern pine arms. A solution of pentachlorphenol in petroleum was used instead of creosote for the cold bath. Pentachlorphenol is a comparatively new wood preservative, being practically soluble in water and leaving the surface of the wood clean.

About 1,100 cross-arms were treated at a time. These were laid in a tank and kept from floating by steel rails secured to the tank sides. Heavy lids were put on to hold heat, prevent excessive evaporation and keep out rain. The hot-and-cold bath non-pressure treatment was then applied. Creosote, heated to above 220° F., was pumped in to fill the tank. From two to four hours later, depending on the condition of the timber treated and the outside temperature, this creosote was pumped off. As soon as possible, and while the cross-arms were still hot, the tank was filled with a 5 per cent solution of pentachlorphenol in an aromatic petroleum at 90–125° F. After allowing another two to four hours for this solution to be absorbed, the tank was again drained and the cross-arms removed for stacking.

At the end of the cold-bath treatment, the sapwood was completely penetrated and the heartwood was penetrated around the pinholes. Retention of preservative solution varied with the amount of sapwoo

present, averaging about 8·5, 6·4, 0·6 lb. of solution per cubic foot of wood for red pine, jack pine and heartwood inland fir, respectively, in the sections between pinholes.

The treated arms were stacked for curing by a method recently devised by the Bell Laboratories to keep end checking, splitting and warping to a practical minimum. They were laid on a sturdy foundation of 8 in by 8 in. timbers with their ends well protected by overlapping alternate tiers. After curing, part of the arms were X-piled, to determine their tendencies, if any, to bleed, warp and split.

Breaking tests on sample arms indicated that inland fir is practically as strong as the current standard coast-type fir and southern pine arms, and that red and jack pine are about 80 per cent as strong.

Successful non-pressure treatment of red pine, jack pine and inland fir cross-arms with hot creosote, followed by cold pentachlorphenol dissolved in a suitable petroleum, opens new avenues of relief in a restricted lumber field. Other woods may be used provided they are strong enough and will take preservative treatment. For example, ponderosa pine, western hemlock and larch are all worth considering, if the supply situation warrants it. On the basis of work already done, the Bell Laboratories recommend the more promising substitute woods for cross-arms, and standard specifications have already been revised to include red pine, jack pine, lodgepole pine and inland fir.

FORTHCOMING EVENTS

Saturday, January 6

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2 30 p.m—Sir Harold Spencer Jones, F.R S "Astronomy in our Daily Life", 5 · "Clocks and Time Keeping" (Christmas Lectures).

Monday, January 8

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W C.2), at 2.30 p m.—The Rt Hon. the Earl De La Warr: "British Agriculture and World Conditions".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 5 p.m —"The Burmese Scene" (Recent Kodachrome Films with Commentary by U. Myat Tun)

INSTITUTE OF FUEL (NORTH-EASTERN SECTION) (at the Central Station Hotel, Newcastle-upon-Tyne), at 5 15 p.m.—Prof. H. L. Riley, Mr. J. Blaydon and Mr. H. E. Gibson · "The Molecular Nature of Coking Coal Bitumens"

Tuesday, January 9

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 2 30 p.m.—Sir Harold Spencer Jones, F.R.S., "Astronomy in our Daily Life", 6: "Finding Position at Sea and in the Air" (Christmas Lectures)

ILLUMINATING ENGINEERING SOCIETY (at the E L M.A Lighting Service Bureau, 2 Savoy Hill, London, W C.2), at 5 30 p m.—Mr. R Gillespie Williams: "The Poetry of Light".

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5 30 p m — Discussion on "Lay-out of Road Intersections" (to be opened by Mr. A. J. H. Clayton).

Wednesday, January 10

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2), at 1.45 p.m—Mr. G. R. Critchley: "How Wrecked and Sunken Ships are Salved" (Dr Mann Juvenile Lecture).

INSTITUTE OF FUEL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C 2), at 2.30 p m.— Sir Alfred Egerton, F.R S., and Mr. Malcolm Pearce: "Methane".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 4.30 p.m.—Dr G. B. B. M Sutherland and Dr. H. W Thompson: "Spectrographic Methods Applied to the Petroleum Industry".

Friday, January 12

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the APPLIED MECHANICS GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p m.—Mr. A. Fogg · "Fluid Film Lubrication of Parallel Thrust Surfaces", Dr. D. Clayton: "An Exploratory Study of Oil Grooves in Plain Bearings".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. H O. Walker: "Notes on the Buchi System".

Friday, January 12—Saturday, January 13

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (DIVISION FOR SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE) (at the Royal Institution, Albemarle Street, Piccadilly, London, W 1).— Conference on "The Place of Science in Industry" (to be opened by Sir Richard Gregory, Bart , F R S)

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

British Rubber Producers' Research Association. Publication No. 53: Distribution of Oxygen in Oxidised Rubbers By R F. Naylor. Pp. 10. Publication No 54: The Interaction between Rubber and Liquids. Part 5. The Osmotic Pressures of Polymer Solutions in Mixed Solvents, Part 6 · Swelling and Solubility in Mixed Liquids By G Gee. Pp. 18. (London: British Rubber Producers' Research Association.) [2112

Hope for the North-East. Pp. 16. (Newcastle-upon-Tyne: Association of Scientific Workers) 3*d*. [2812

Catalogue

Annotated Catalogue of Works on Physics, including also Items on Collateral Sciences, and comprising the Library of Prof. John Tyndall. (No. 873.) Pp. 88. (London: Henry Sotheran, Ltd.)

NATURE

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CONTENTS

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DEMOBILIZATION OF UNIVERSITY STUDENTS

UP to the time of writing, no pronouncement has been made by the Government in regard to the release from the Armed Forces of university teachers, or of students to resume their interrupted studies. The national importance of dealing with this matter without delay was discussed at some length in an article in *Nature* of December 23, in which we emphasized the necessity of arriving at a satisfactory solution of the problem of the demobilization of students, and one which would ensure that the Government would not have to face misguided criticism of giving favoured treatment to a particular class of men.

The resumption by the universities of a large part of their normal activities in October 1945—if the military situation permits—is a matter of vital public interest; for there is abundant evidence of the difficulties which are likely to arise from the continued interruption of the supply of university graduates, especially in the faculties of arts and economics. The number of trained men likely to be available from these faculties, in the next few years, for the public services, for commerce, industry and for the teaching and other professions, has been reduced almost to the vanishing point. The question of the release of university teachers from temporary war-time posts in the Civil Service is already being dealt with by means of the committee appointed under the chairmanship of Lord Kennett to consider and decide applications from universities and colleges for the release of such of their staff from Government employment as they consider to be more urgently needed at the present time in their academic posts. It is to be hoped that arrangements for according a high degree of priority of release—in suitable cases—to university teachers now serving with the Forces will soon be made, for the re-staffing of the universities must obviously precede the acceptance by them of additions to the student body.

It seems to be generally agreed that in releasing students from military service, the national interest would be best served by giving the first opportunity of completing their university education to students of the highest intellectual ability. The test of intellectual ability by success in an examination is admittedly not infallible; but it is no doubt generally the case that the best and most promising men are to be found among those who have gained such awards as open scholarships or exhibitions at universities, State scholarships, or certain other scholarships awarded on a highly competitive basis. In the national interest, these are the men who should be sent back to their studies at the first opportunity, so that their services may be available to the nation in the early post-war years.

Before deciding on any scheme for the release of men for university study, its effect on the universities and colleges should be carefully considered. Many more scholarship holders go to Oxford and Cambridge than to the newer universities, and a scheme for

giving priority of release to men who have won scholarships would set free considerable numbers of students already entered at one or other of the older universities, and relatively few already accepted by the universities of the provinces. If we take the figures for recent pre-war years published in the returns from universities to the University Grants Committee, it appears that the average annual intake, by all the universities of Great Britain, of men students (exclusive of those entering faculties of medicine, which class will doubtless continue to be reserved) was in round figures about 9,000. In view of the destruction by enemy action of university and college buildings, including libraries, laboratories and hostels, and of the difficulties of getting together, in a short time, adequate and competent staffs, it seems unlikely that the universities could manage to provide in their non-medical faculties for a larger entry than 9,000 men (together with the normal proportion of women) in the initial year of peace. An estimate of the number of students who would be eligible for release, in view of their having won scholarships or other high awards in open competition, is not easy. Some will have become casualties or prisoners of war, or perhaps be unwilling to return to academic study after an interval of several years; but it seems probable that there might be about 2,000 scholars wishing to return to their studies at Oxford or Cambridge, possibly 1,000 for the colleges of London, and about another 1,000 who have gained admission and open awards to other universities of Great Britain. If these men were demobilized in time to enter their universities in October next, they would provide Oxford, Cambridge and London with about two-thirds of their normal annual entry of non-medical students; but the average entry from this source to the other universities would be only about one-fifth of the normal pre-war number. The total number so released from the Forces for university study would be about 4,000, and it is perhaps unlikely that, with all the claims which will be pressed upon the Government for Class B releases, a larger number of university students could be spared in time to enter upon university courses at the beginning of the Michaelmas term. But it is certainly desirable that the number should be sufficient to enable the provincial universities to approximate to their normal activity by starting the coming session with a reasonable number of students in each of their faculties.

If the military situation should allow of a greater total number of releases for October next than can be satisfied from the open scholarship class, it would appear to be reasonable for any margin to be filled by the release of other men who have completed part of their university course before entering on their war service, and concerning whom the universities have some information and grounds for discriminating relative merit and ability. Clearly the selection of individuals as suitable for immediately taking up their interrupted studies could best be made by the universities themselves; but the final selection from those judged to be qualified should be decided by considerations of age and length of service in each case.

In addition to the desirability of arranging that the universities should be able to open for the session 1945–46 with a reasonable number of students, there is the necessity that they should be assisted to organize themselves so that, if war in the European theatre has ended, they may be ready to deal with a normal number of students in all faculties in the Michaelmas term of 1946. Most universities are only able to deal with students who join their courses at the beginning of a session, and releases for university study should be arranged so that the men will be ready to commence work by the end of the month of September. Clearly, a generous allocation of Class B releases might be made to university students in August 1945 on the ground that it would be inexpedient to make any further releases for university study until August 1946. In this respect the problem of the demobilization of students is quite different from that of arranging for the release of men who can return to civilian employment at any period of the year.

The advantages which students gain by residence in a college or university hostel during their academic courses have been strongly stressed in many quarters recently, and universities are rightly pressing upon grant-giving bodies the need for increased residential facilities. From the national point of view, the scheme of releasing from the Armed Forces and from other national service, in the first instance, those students who are in the open scholarship class, has the advantage of making use of most of the available university residences in the country; for a large proportion of the men so released would already have gained admission to one or other of the colleges at Oxford or Cambridge. But it should be stressed that the primary qualification for early demobilization would be proved ability to profit by advanced education, and the promise of becoming qualified to play an important part in the national life, not that the man would be returning to a particular university.

In considering the question of demobilization from the point of view of its effect on the universities, it must be remembered that the number of places available for men released from national service depends on the number of students allowed to enter universities direct from school, and on the number of those at present in residence to whom deferment of military service is granted. If the arrangements for granting deferment to students entering the universities in October next should prove to be less generous than those now in operation, the effect may be that, in spite of releases from national service, a considerable reduction in the total numbers of men in attendance at university courses will occur. This reduction would be most marked in those universities which have large faculties of science and engineering, and which have been assisting the national effort by concentrating on the training of technical specialists in subjects in which the acute shortage a few years ago was a hindrance to the effective prosecution of the War. It may now be right to reduce the output of trained scientific men and engineers in favour of an increased supply of specialists in other branches of university study; but the problem is complicated

and difficult, and involves a nice balancing of the probable future requirements of the nation against the military needs of the moment. The latter will doubtless change in the course of the year, and the best method of dealing with the matter would seem to be by keeping in being the existing joint recruiting boards at the several universities, and using them to direct the activities of all male university students, not only those of technical and scientific subjects. This would provide a ready means of adjusting periods of deferment to suit changes in the national situation. But in thus controlling the numbers admitted to university courses, and the length of course permitted in different subjects, it should be borne in mind that for the production of a trained scholar or technician, a long period of uninterrupted study is most desirable. It would appear to be in the national interest that all the more able students should now be directed to follow the full normal university courses in their subjects.

When Germany has been defeated and demobilization on a larger scale begins, the universities may find themselves flooded by applications for admission from men released in Class A, as well as those in Class B whom we have been considering. All would desire that as many men from the Forces as are suitable should be given the opportunity of further education at the university level. To provide for this it may prove to be necessary to delay the entry of young boys, direct from school, by sending them first to do a year of national service in accordance with a deliberate national policy on the lines suggested in the Norwood Report. It is certainly undesirable that such a congestion of students should occur in universities as would necessitate the continuation, even for a few years, of the inelastic organization of courses which has been necessary in many cases in dealing with the inflated numbers of students reading certain scientific subjects during the last few years.

WELSH FARMING

The Agriculture of Wales and Monmouthshire
By Prof. A. W. Ashby and I. L. Evans. Pp. iv+300. (Cardiff: Press Board of the University of Wales, 1944.) 15*s*.

IT was a very happy arrangement that Principal Ifor Evans and Prof. A. W. Ashby should combine to prepare a book on the agriculture of Wales. They have confined themselves mainly to the period for which official statistics are available, namely, from 1867 to the present time, and Prof. Ashby's wide knowledge of this branch of the subject has enabled him to avoid the pitfalls into which a less expert writer might have fallen. Ifor Evans knows the human side, and has been able to add the descriptive detail that puts life into the official figures.

The authors are fortunate in their period. In the early part, Welsh farming was mainly subsistence farming; each family ran its holding and produced the food needed: wool also was produced for clothes, and with the aid of a few craftsmen settled in the villages all the ordinary needs of life were supplied. The centres of the communal life were the chapel and the local Eisteddfod, and there were various activities associated with these that brought the young people together. Actual cash transactions were few, limited to rent, rates, and an occasional special event, and these were met by the sale of cattle or of sheep. Petty cash for special household needs was obtainable by those near a market, but not everyone was in this position. I well remember the market at Carmarthen in 1891–92, to which the country-women came dressed in their tall-crowned hats, shawls, bodices and a bulky array of drab-coloured petticoats; they brought with them eggs, poultry and butter, the chief characteristic of which was its great variation in quality, no two samples ever being alike, but all being poor. The pitiful thing, however, was the low level of prices, for there was no organized marketing and the sellers did not wish to take their produce home unsold It was a peasant community, and its problems could find a parallel in any of the peasant countries of Europe

Then came the great change. From the early days of this century the subsistence farming gave place to farming for the great markets of England and South Wales. Things were produced for sale, and not for home consumption; the people ceased to be peasants and became small farmers. The change took a long while; indeed the authors do not think it was complete until 1939. They trace in great detail the changes involved. Livestock and livestock products became more important and arable crops less: the reduction in these, especially grain, is very graphically shown. Unfortunately, the change was accompanied by a general abandonment of liming, which had previously been common; the early agricultural advisers were not blameless here, for they too often thought that the basic slag they were busy introducing could take the place of lime.

Once Welsh agriculture was fairly on the sales basis, its history was not unlike that of English farming; it was subject to the same economic factors, enjoyed temporary prosperity during the two Wars and suffered from the severe slump that came in between. The livestock figure for 1916 marks a record high level which was only just passed in 1937, while that for 1920 is the lowest in the present century. But the authors are careful to note and explain the differences between Welsh and British farming, which are numerous.

The Welsh farm still remains essentially a family affair: farmers and their relatives accounted for more than 60 per cent of those engaged in agriculture in the last census (1931). Even so the number of 'male relatives' working on the farms decreases, and the staff tends to reduce itself to the farmer, his wife and his children. One difference from English practice is brought out: when the parents die, the inheritance is divided equally among all the children; whoever takes the farm has to buy out his brothers and sisters, and this may land him in debt, with awkward consequences. Yet the system works, for in a sample survey, 75 per cent of the farmers were sons of farmers, while only 11 per cent were sons of farm workers and 7½ per cent sons of other manual workers.

The authors state, with some reserve, that nearly half the arable land and pasture of Wales was in 1931 in farms of 50–150 acres, and less than one quarter in farms of 150 acres and more. These two groups of farms employed less than one half the total number of full-time farmers.

Livestock, especially milch cattle, are now the central feature of the farming, and this has empha-

sized the need for improving the grassland. There is a steady rise in the proportion of cows and heifers, and a fall in that of older cattle for meat production This has of course led to a marked increase in milk production.

So far as actual numbers go, sheep are the most important element in Welsh live-stock, and, as for cattle, the number was lowest in 1920 and highest in 1939. As in England, however, a diminishing number live more than one year, the taste for fat mutton having gone, most are killed or sold as lambs, and only the breeding ewes are kept. The lowland farmers have devoted much attention to the production of early lambs

Pigs have always furnished much of the meat of rural Wales, but they too now enter into commerce, especially for bacon production.

The change-over from subsistence farming to farming for the market meant of course that the farmers became liable to all the risks of competition from outside, to the vagaries of prices which lay right beyond their control, and to other troubles. On the other hand, the young people prefer the new life, and however much on sentimental grounds one may regret the passing of the old, one must admit it had many bad features. Farmers now have more scope than in the old days; they can benefit by organization—by co-operation and better marketing. They can take fuller advantage of agricultural education and research, and make better use of improved methods and appliances than was formerly possible Co-operation has not developed as much as it might; 'societies' supplying requisites have proved more popular than those dealing with produce. Welsh farmers, however, have always been keen on education: indeed, the College at Aberystwyth is in part a tribute to their interest. The Welsh farms and villages have always supplied a high proportion of excellent students. It is therefore all the more surprising to read that agricultural education and advice, as organized by the Welsh counties in the 1930's, did not exercise any noticeable influence on more than 20–33 per cent of the agricultural population.

The volume is so well documented that the appendixes extend to well over one hundred pages while the text covers one hundred and seventy pages. But these appendixes are full of valuable information not easily obtainable elsewhere, and they include an extensive set of statistics with annotations, for all of which students will be deeply grateful.

The authors have accomplished with great distinction a difficult task and they have set a standard to which other writers on the agriculture of a region will do well to aspire.

One good book always evokes the desire for another. Would it be possible for the Honorable Society of Cymmrodorion and the Press Board of the University of Wales, which have produced this book so well, to give us a history of Welsh agriculture going back to the most ancient times? Early records may be scanty, yet the National Library has a big collection of manuscripts from which something might be gleaned. One would expect the earliest agriculture to have some relation to the early farming on the open lands of the south of England: but had it? In any event, where did the old varieties of cereals come from—Hen Gymro, Ceirch Llwyd, Ceirch du bach, Haidd Garw, and others? They certainly were not indigenous, nor were the old Welsh animals.

E. JOHN RUSSELL.

THE INTERNATIONAL PETROLEUM POSITION

Peace, Plenty and Petroleum

By Benjamin T. Brooks. (Science for War and Peace Series) Pp. vi + 197 (Lancaster, Pa: Jaques Cattell Press, 1944) 2.50 dollars

THIS review of the present position of the American petroleum industry may not prove particularly palatable to those nurtured on the pleasant theory that undiscovered reserves in the United States amount to "some comfortable astronomical figure", to quote the author's own words. Indeed, it will be a hard task for a nation which has for many years produced 65 per cent of the world's oil to adjust its independent viewpoint and face the fact that its domestic production is no longer adequate to its own needs. America has become an oil-importing country, and if present trends within the industry continue, she will become increasingly dependent on foreign supplies

Furthermore, the author is of opinion that even with the cessation of hostilities, shortage of crude oil will persist. Petroleum is the basic essential of all forms of modern warfare, without it, navy, air force and army would be immobilized. Production has, however, been pushed to an artificial peak to supply the amount of fuel sought by the U.S Petroleum Administration for War, but the record figure of 4,200,000 barrels a day attained in the summer of 1943 cannot be maintained indefinitely. The yield of a majority of fields has been increased beyond the optimum economic rate of flow, and estimated reserves have correspondingly diminished. Recent decline in the rate of discovery of new resources aggravates the seriousness of the position, particularly when it is apparent that exploration activity has not shown a parallel decline. Figures published by Mr. E L. De Goyer, deputy administrator of the Petroleum Administration for War, show that in 1937, when the discovery-rate first showed a decline, 2,224 wild-cat wells were drilled, while in 1942, 3,045 wild-cat wells were drilled.

It is not thought likely that shortages of crude oil in the United States will be met for some time to come by the manufacture of substitutes. Only when price-levels of crude petroleum and its products are substantially higher than at present will it be commercially feasible to produce fuels in quantity from shale oil, coal, water gas or alcohol, and in any event manufacture of such substitutes on the scale required could scarcely be improvised in war-time. Immense new fields have been discovered and developed in other countries, particularly during the past ten years, and it seems reasonable to suppose that domestic shortages in the United States will be made up by importations from Venezuela, Colombia, Mexico, and possibly from Saudi Arabia, Iran, Iraq and the U S S.R. Thus the success of American oil companies operating abroad has become a matter of national importance, and, according to the author, "it is not too much to say that the much derided dollar diplomacy has come back into our [U.S] State Department with some new improvements".

The book is, by design, thought-provoking and challenging. At a time when a series of international conferences regarding the world's oil is envisaged and when the United States is beginning to plan a foreign oil policy, the author feels that the public is entitled to know the full story of the petroleum industry to

date. Under various chapter headings he reviews economic problems concerning oil in world power politics, difficulties and hazards of foreign oil production and the part which oil seems destined to play in the post-war world. In addition there are informative chapters on petroleum substitutes, the geographical distribution of oil, chemistry of petroleum and the growth of the petroleum industry.

Mr. B T Brooks is well qualified to write a book of this character, having had thirty-two years experience in the petroleum industry. The book is written primarily for the American public, but there are many in Great Britain who will find it interesting, and indeed it is highly desirable that problems facing the American petroleum industry should be fully understood here There is no doubt that as 'co-importers' of foreign oil, Great Britain and the United States will have many problems to face before international agreement is reached on the best method of exploiting world resources of petroleum. The author suggests that "international co-operation after the war will evidently involve a world rationing of such things as petroleum, with quotas, at least to certain nations. International agreements regarding oil means Britain and the United States, and possibly Russia, and this in turn means that private companies must operate within the frame-work of such government agreements. It means a kind of world-wide oil cartel, with the blessing of our own and other governments, although with the foreign policy makers laying down the rules."

A CRITIQUE OF PASTEURIZATION

The Case Against Pasteurization of Milk

A Statistical Examination of the Claim that Pasteurization of Milk Saves Lives. By John P. Bibby. Pp. 71. (London: Staples and Staples, Ltd., 1944) 1s. net.

THE three main theses of this booklet (written as a critique of Prof. G. S. Wilson's book "The Pasteurization of Milk") appear to be (1) that "exposure to light infection" by active tubercle organisms is the best way to induce human resistance to tuberculosis; (2) that the regular consumption of raw milk infected with bovine tuberculosis is a feasible way of developing such resistance, and that the encounter with infective material should take place at an early age—in short, that the consumption of tubercle-infected milk by young children is to their ultimate benefit, (3) that pasteurization not only does us the disservice of preventing this "exposure to light infection" but also seriously damages the milk nutritionally, "devitalizing it at source", an impairment that, it is stated, can be to some extent corrected by adding vitamin D to the diet.

No one would contest Mr. Bibby's view that serious tuberculosis in man should be combated in every possible way, but the logical corollary to his theses (1) and (2) is that the owners of tuberculin-tested herds who at present receive 4*d*. premium for each gallon of milk produced should be penalized and not rewarded. The premium should, presumably, be paid for milk 'lightly infected' with *M. tuberculosis*. Cows with tuberculous udders—doubtless not *too* severely infected—would appear to be a national asset as an insurance against human tuberculosis. Still more should this apply to the lactating tuberculous woman, one wonders whether Mr. Bibby would knowingly put a young child of his own to the breast of a tuberculous wet-nurse?

But even if it were possible to effect satisfactory immunization against tuberculosis by the oral route—a dubious assumption—medical and public opinion would insist that the method should be controlled. Definite numbers of organisms of standard virulence would have to be used, and if the milk to be given to young infants were to be thus artificially infected, it would have to be free from the risk of producing other diseases at the same time, that is, it would have to be previously pasteurized or from absolutely disease-free herds. Moreover, if individual immunity could be acquired in this way, it would have to be acquired in each generation—a grim prospect

One comment on thesis (3) is not unfair. If the nutritional case against pasteurization has to depend on the selection of statements from early experimenters whose work has not stood up to modern re-investigation, then it is poor indeed. In discussing the effect of pasteurization on the nutritive value of milk, the author quotes nothing later than 1931; this is not done in ignorance, for much of the more recent work, which uniformly does not support this thesis, is quoted in Prof Wilson's book.

H. D. KAY.

VIRUS DISEASES

Virus Diseases in Man, Animal and Plant

By Gustav Seiffert. Translated by Dr. Marion Lee Taylor. Pp. ix+332. (New York: Philosophical Library, Inc. 1944.) 5 dollars.

THIS edition of Seiffert's work is a translation by Marion Lee Taylor. The book is divided into five main sections. Section A is a 'General Division' in which the main properties of viruses are discussed; Section B gives a brief review of "Certain and Questionable Virus Diseases of Man, Mammals and Birds"; Section C deals with virus-like organisms such as the Rickettsiæ, bacteriophages, *Bartonella* and the agents of pleuropneumonia and agalactia. Section D is concerned with filtrable bacterial forms, and in Section E a short and incomplete description of the laboratory methods of virus investigation is given. In view of the wide scope of the book, it is possible in the space allotted to consider only the superficial aspects of the different subjects under review

The original German version was undoubtedly a useful contribution to the literature on viruses, and probably fulfilled the aim indicated in the preface, namely, "to furnish an introduction for the many who wish to occupy themselves more closely with the virus problem, to make possible by references to literature further penetration into the subject. . . ." This present edition is, however, unlikely to serve any useful function. It is an almost literal translation from the German by someone who does not appear to be particularly conversant with either the viruses or the virus-diseases. In consequence, the contexture is difficult to follow owing to the close adherence to the original German construction, and many terms, unfamiliar to the British bacteriologist, have been included. Furthermore, although numerous references to original papers are given, all concern articles written prior to 1938. There has been no attempt to bring the edition up to date. R. W. F.

THE GAS INDUSTRY: YESTERDAY AND TO-MORROW*

By Dr. E. F. ARMSTRONG, F.R.S

History of Gas Lighting

As a provider of one of the four basic necessities of life (food, shelter, clothing and warmth), gas is a leader among British industries. It carbonizes annually 20 million tons of coal, making more than 1,700 million therms of gas. It is the nation's third biggest ratepayer, one of its largest employers of capital (£200 million), its seventh largest direct employer of labour.

It is a hundred and fifty years since William Murdoch in 1792 first lighted up his house at Redruth with gas generated from coal in an iron retort in his back yard. He also had a gas lantern constructed, with the jet attached to the bottom of the lantern and a bladder of gas underneath, with which he lighted himself home at night across the moors when returning from his work to his house at Redruth

Many years later (in 1818), when Murdoch was at Manchester for the purpose of starting one of Boulton and Watt's engines, he was invited, with Mr. William Fairbairn, to dine at Medlock Bank, then at some distance from the lighted part of the town. "It was a dark winter's night," wrote Mr. Fairbairn, "and how to reach the house over such bad roads was a question not easily solved. Mr. Murdoch, however, fruitful in resources, went to the gasworks (then established in Manchester), where he filled a bladder which he had with him, and, placing it under his arm like a bagpipe, he discharged through the stem of an old tobacco pipe a stream of gas which enabled us to walk in safety to Medlock Bank."

Murdoch was followed by Samuel Clegg, who installed gas in factories and other buildings and produced many inventions calculated to make its use practicable. Together with F. A. Winsor, his efforts led to the foundation of the first gas company, the Gas Light and Coke Company, which to-day is still the largest in the world. Gas became the fashion, and by 1829 there were already some two hundred large and small companies.

Lighting was its primary function in those days—what a boon it must have been. It made street lighting possible and did much to put down crime. At first the extremities of pipes had small apertures; later came the batswing and fishtail burners, followed in 1850 by the Argand burner with an air regulator. Suggs invention of the governor, a pressure-controlling device, nearly doubled the light given by the street lamps.

Just a century after Murdoch's start, gas lighting was given new vigour by the discovery of the incandescent gas mantle, which made use for the first time of the heating and not of the illuminating ingredients of gas. This discovery came just as the new electric light was becoming a competitor. I well remember as a boy my father telling us at breakfast of a dinner party at Joseph Swann's the previous night in his dining-room lighted by electricity, the first to be so equipped.

I must resist the temptation to trace the historic development, allowing myself only one incident which refers to the Royal Institution. In 1818 a committee was appointed "to take into consideration the expediency of lighting the Institution with gas instead of oil". Those were leisurely days and nothing appears to have been done until 1828, when another committee was appointed which "recommended the use of Portable Gas for lighting the library and lecture theatre on Friday evening meetings". This supply lasted until 1834, when the Portable Gas Company went out of business. Coal gas from the street mains was substituted But this bare statement hides Faraday's personal contact with the Portable Gas Co., begun, no doubt, at the time of the first committee. It was in the gas provided by the Portable Gas Co. that he discovered benzene in 1825: it was not until twenty years later that its presence in coal tar was proved. So the attempts of the Royal Institution to be up to date and use gas to light its rooms was responsible for one of the greatest discoveries in organic chemistry.

Prior to the advent of the incandescent mantle, it was the 'illuminating' ingredients of gas that mattered, and the strict supervision of quality carried out in accordance with the City of London Gas Act of 1868 expressed this illuminating value in terms of standard candles. When heating became the criterion of quality, these illuminating constituents ceased to be of importance, and in 1904 a Board of Trade Committee recognized the calorific value of gas, though it was not until 1920 that the change from an illuminating to a calorific value standard was made law. Gas was henceforth charged for not by volume but by calorific value expressed in therms.

By this time technical development both in the refractory materials used to construct the retorts and in the art and practice of carbonization made it possible to use higher temperatures so as to obtain a greater yield of gas per ton of coal. This is still the goal of every gas engineer. Such gas has calorific value, but has largely lost its illuminants. The change, therefore, encouraged good technical practice and opened the way to the modern use of gas as a heating agent.

But before I leave lighting I must make some reference to street lighting, because this is a field in which gas still holds its own. For internal lighting the convenience of the switch and considerations of decoration have enabled electricity largely to replace gas even at the expense of the quality of the light and its effect on eyestrain. Some of the best street lighting in London before the 'blackout' was by gas burned in high-pressure incandescent lamps. A convenient comparison, which shows the advance made, is in terms of candle-power per cubic foot of gas consumed per hour. In 1899, using flat-flame burners, this was 2·5; the substitution of mantles in 1902 made it 14; a figure increased to 19 when the mantles were inverted in 1913; finally, in 1931, high-pressure lamps brought the figure up to 42·5. The lamps in Whitehall gave an illumination of 2,500 candles in a direction at right angles to the surface of the mantle.

Manufacture of Gas

I myself think of the gas industry in two parts one, the manufacture of gas and the technical skill and future developments associated with it, the other, the distribution of the gas, its burning in suitable appliances and the service given to the consumer.

The making of gas is a highly specialized and skilled operation, especially in a large gas works. There has been continuous progress, and although to-day the thermal efficiency of gas-making is 80 per cent, the gas engineer has never been more active in seeking

*Royal Institution discourse delivered on November 24

new means of advance for the future. The two main desiderata at the moment are the lowest possible price for gas and the maximum economy in the use of coal.

One approach is completely to gasify coal, that is, not to make coke for sale. Many undertakings turn part of their coke by treatment with steam into water gas. This is a convenient way of adding to the make of gas at the time of peak loads. An alternative involves a pressure process of gas-making, the coal being carbonized in presence of hydrogen. The process takes place in two stages, the first forming a gas rich in methane together with a primary tar and some carbonaceous residue. This residue is fed to a producer operating under pressure and supplied with oxygen and steam in which the hydrogen requisite for the first operation is produced. There is a possibility, according to Dr. E. V. Evans, of producing from 1 ton of any coal—value 300 therms—some 210 therms of gas, together with a tar which can be hydrogenated to petroleum products and also compressed hydrogen. This possibility—the making of methane from coal—is being followed up with the full energy of the Gas Research Board.

Yet another process under study by the Board involves the production of methane catalytically at low pressures. Success in this process would replace some of the gas oil required when water gas is manufactured, and give some control over coke production; but it would not enable the use on gas works of any kind of coal.

A suggestion is to gasify the coal underground, as is said to be done in the U.S.S.R. There is little information available, and no evidence that this process is a success or that it is applicable to British conditions. It has been tried with poor seams, probably uneconomical to work as coal, and gives a gas of low calorific value.

Much can be done by selecting those seams of coal most suited for gas-making. The Fuel Research Board is making a careful survey of the coal of Great Britain, having regard to its suitability for particular purposes. The best form of fuel economy is to use each type of coal where it gives the best results. Unfortunately, such ideas do not commend themselves to the officials who now control these matters: to them coal is coal.

The making of gas resolves itself into the devising of plant in which, during the treatment of coal by heat, the conditions of cracking are such that satisfactory yields of the desired products are obtained.

Coal is a complex hydrocarbon of definite molecular structure; when it is carbonized, nascent hydrocarbon oils are distilled from it which are then decomposed and hydrogenated. The chemist has sought to gain an accurate picture of what is taking place in the retort, so that the engineer may apply this knowledge to practice and obtain the maximum number of therms from a ton of coal—which is to-day about 75. Such factors as the size of the charge of coal into the retort, rapid or slow carbonization and very many technical considerations have all been studied. One of the main objects is to avoid cracking the volatile products and so producing more than a minimum of free carbon. Such studies have also to include the physical characteristics of various coals.

I have alluded to this work so as to make it clear that carbonizing coal is not a rule of thumb operation, but one based on much scientific study, of which the principles are now well understood.

Carbonizing in all its branches is a continuous struggle on the part of the maker of refractories to provide bricks and retorts which will have a long life at high temperatures so as to meet the demands of the users. Much research is going on in this direction.

Distribution of Gas

Now a word on the distribution side, for it is an important and costly item in the supply of gas to every home. The providing, laying and servicing of gas mains is a highly developed technique. Obviously the more customers which can be supplied per mile of main the better; ribbon development, with supply to scattered customers, is more costly. There is a limit to the distance to which a gas main can be carried economically without a substantial user of the gas en route. This has brought up the question of the co-ordination and grouping of separately controlled units, each working in a restricted area, into larger centralized companies linked up to ring-main distribution systems giving a supply of constant quality, purity and pressure. The gas engineer is fully alive to the importance of these three criteria, and although perhaps he has sometimes been at fault in the past, in this respect he will not be found so in the future.

The householder, however, is not interested in gas until she begins to use it. For this purpose appliances are required, appliances which are becoming more complex and more costly and therefore impossible for the ordinary consumer to buy. Hence the development of hire purchase and simple hire systems by the gas undertaking, and the servicing of these so that they are in perfect order. To obtain regulated heat to-day for cooking, space heating, water heating or other purposes, nothing more is required than to turn on a tap and light the gas with a match or other means. The consumer saves all his own personal labour and trouble; he has to keep no stocks in his coal cellar. The undertaking supplies serviced heat, and this is what is really being paid for. Comparisons of the cost of coal and gas per therm have no meaning whatsoever. Coal has to be carried, the ashes removed, the dirt cleaned and the purchase financed months in advance of use. It is this service which is to-day, and still more to-morrow, the function of the gas industry. New and more economical forms of appliances are being devised, and they have to be decorative as well as efficient—not always the most easy combination. The useful geyser has been replaced by the instantaneous water heater; the modern cooker is a triumph of labour-saving and efficiency; the gas fire has all the virtues except that of portability.

It is not my task to explain modern gas appliances, but I do want to direct attention to the latest development of heating by the non-aerated-gas type of burner sometimes called luminous heating.

Before the War, only some gas undertakings extracted the benzol from coal. It is now compulsory. Gas no longer therefore contains any constituent that burns with a smoky flame, and hence 'excess' air mixed with the gas in the burner is not required to burn it. Enough air is drawn into the flame at the aperture to burn the gas completely. Such flames are silent in operation, they are not cooled by excess air and have many advantages both in cookers and gas fires. Other advantages are immunity from back lighting, less choking of jets by dust and less need for maintenance attention. This type of heating marks definite progress.

Gas Tariffs

The method of charging for gas is one of moment to both supplier and consumer. To-day gas is measured

by meter, and the quantity used is charged for on the basis of its calorific value, that is, by the therm. Gas is essentially the poor man's fuel, and the prepayment meter has made it easy for him to obtain it in small amounts as desired for cash. Larger consumers have their meters read quarterly and have that amount of credit.

Actually a far more satisfactory method of charge capable of leading to progressive development would be similar to that adopted for the telephone and by the electrical industry. In both these there is recognition of the service rendered by having the commodity on tap: a fixed annual charge covers the overhead charge of the service and enables the commodity charge to be low. This would mean that extra use of gas above a minimum becomes cheap and therefore attractive. As it is, most of the small users of gas are unremunerative to the industry. An attempt to alter this state of things in London met with considerable opposition probably because the ground was not sufficiently prepared for its wisdom to be understood. Dr. E. V. Evans, the acknowledged technical leader of the gas industry, outlined a little more than a year ago an ideal scheme for a unit community involving the co-operation of the two services gas and electricity, for the development of an ideal balanced fuel-supply. It incorporated a fixed charge for the ordinary dwelling house of 40*s.* per annum and a supply of gas at 6*d.* for the first 300 therms and 4*d.* a therm afterwards. The charge to the domestic consumer must include payment for the services given him; whereas the charge to industry is for a convenient heating material in bulk and does not include services. It can be directly related to the cost of coal.

The Relationship of the Gas and Chemical Industries

A problem of interest for the future is the position of the gas industry as a source of raw materials for the chemical industry, in particular the new synthetic chemical industry from which so much is hoped in the days to come. In the past, much of the organic chemical industry has been built up on tar products—notably benzene, toluene and naphthalene; but the demands of chemists have only taken a little of the tar made, so that other uses have had to be found for the bulk of it. This problem has been largely solved by the use of tar on the roads—not haphazard, but in the form of tar carpets scientifically designed.

The motorist has taken the surplus benzol at a price which includes the tax on imported petrol: this demand is resulting in all the benzol being scrubbed out of gas. This can only take place if the price paid for it represents the value of the benzol as therms in the gas and the cost of separating it. The chemical industry wants cheap benzol and is reluctant to pay the equivalent of the hydrocarbon duty on it.

Gas also contains ethylene, while its main constituent is methane. Are these worth more to chemical industry than to gas as therms? Since Great Britain has only a very small oil-refining industry, it largely lacks the two carbon compounds from which most organic syntheses start. The problem is, Shall the gas industry concern itself only with its legitimate business, the making and distribution of gas, or shall it be in with the synthetic chemical industry and help to make basic raw materials for it? Only the future can answer. Personally, I hold the view that a gas works should be the place in which all coal should be processed, some to make gas for the domestic consumer and for industry, some to make methane, benzol, and other raw materials for chemical industry, and some to make petroleum hydrocarbons. The balanced interlocking of the various processes would lead both to economies in the use of coal, almost Britain's only raw material with a thermal value, and bring about a cheapening of the various products enumerated. Vision for the future is required; but at a moment when an influential Government committee is inquiring into the future of the industry, its potentialities as a scientific coal-processing industry should be given full consideration.

SEED-BORNE FUNGI

On October 28 the British Mycological Society met in Birmingham to discuss certain seed-borne fungal diseases. The programme was arranged by the Plant Pathology Committee of the Society.

The first two papers dealt with fungi parasitizing the seeds of British grasses, and Dr. Mary Noble, in an interesting account of the blind seed disease of ryegrass, directed attention to its effect in reducing the germination of seeds, especially those of the modern 'leafy' or 'indigenous' strains. Since these leafy strains normally seed much less profusely than the commercial types, this added loss is especially serious. The disease is known in New Zealand, where it has caused considerable damage in some recent seasons, and is now widespread in Britain.

The identity of the causal fungus has been the subject of much confusion. The imperfect stage was first erroneously ascribed to Pullularia, while the perfect stage was originally described as an inoperculate discomycete of the Helotiae, but the close similarity of the blind seed fungus to the rye parasite *Phialea temulenta* of Prillieux and Delacroix was observed by Dr. Noble and her colleagues at Edinburgh. Subsequent investigation of the anatomy of the apothecium supported the view that the two fungi were identical, and this was finally proved by Dr. Neill in New Zealand, who examined some of the original material of Prillieux and Delacroix. In addition to rye and *Lolium* spp., *P. temulenta* has been found infecting *Festuca arundinacea*, *F. rubra* var. *fallax*, *Cynosurus cristatus* and other grasses; but its commercial importance so far is confined to the ryegrasses. Infection occurs at flowering time, that is, in late June in Great Britain, at a point on the ovule just below the stigma. Large numbers of conidia are produced externally, but hyphae penetrate more deeply and may completely destroy the embryonic structure. Blind seeds result from rather later infection after the embryonic tissues and the endosperm have been differentiated. Still later infection may result in the production of conidia, but the embryo escapes and the seeds remain viable. Blind seeds are sown with healthy ones, and, provided they are not more than $1\frac{1}{2}$ inches under the soil, give rise to stalked apothecia just as the ryegrass is coming into flower. The production of apothecia continues for about three weeks, and thus both early and late strains of ryegrass are subject to infection. Cool wet weather favours infection, as under these conditions the dissemination of pollen is reduced while the glumes open repeatedly and entrance of the fungus is facilitated.

Since *Phialea temulenta* penetrates so deeply into the seed the disease cannot be controlled by fungicidal dusts, and the only practical way of cleaning large

stocks of seed is to store them for two years, during which time the fungus dies out. In Scotland in 1944 a trial service was set up along the lines of one already functioning in New Zealand, under which growers were invited to send in samples of heads before harvest. These were examined for the disease and a reply sent to the grower within two days advising him as to whether his crop was worth saving for seed or not. This is a great help, as it saves the useless work of harvesting diseased seed, and the crop can be converted into hay.

Single-spore (ascospores or macroconidia) isolations of *P. temulenta* give cultures of two types (*a*) mainly conidial with a smooth shiny type of growth, or (*b*) mycelial in which the surface of the colony is rough, due to the development of white aerial hyphae It is just possible that this mycelial form may be the well-known *Lolium* endophyte, but so far no proof has been obtained that the blind seed fungus can infect its host systemically The various endophytes of *Lolium* were discussed by Miss K. Sampson in her paper on "Some Endophytic Fungi of the Grasses". Darnel (*Lolium temulentum*) has long been known to carry an endophytic fungus situated just outside the aleurone cells of the seed, and *Lolium remotum* and *L multiflorum* also have endophytes which appear to be of a similar nature. In *L. perenne* two types are distinguished. The first occurs in indigenous perennial ryegrass in Great Britain but not by any means in every plant. It was isolated and cultured at Aberystwyth in 1937, and Neill (1941) in New Zealand, by different methods, also cultured a fungus which appears to be identical. Neill observed sporodochia and microconidia very similar to those produced by the blind seed fungus This again suggests the interesting possibility that this *Lolium* endophyte may be a non-fertile strain of *Phialea temulenta*, but there is still the difficulty that nobody has yet shown that the blind seed fungus can cause systemic infection in *Lolium*. The second *L. perenne* endophyte has only been studied at Aberystwyth, and is distinguishable from the first by its mycelial characters and by the comparative ease with which it can be cultured. Its microconidia seem more characteristic of Sclerotinia than of the Endoconidium type figured by Neill for the first *L perenne* fungus. It seems that we still need to clear up many points in relation to the fungi parasitizing *Lolium* spp., but the information given by Dr. Noble and Miss Sampson at this meeting suggests that appreciable progress has been made in this direction. The choke disease of grasses caused by *Epichloe typhina* was also mentioned by Miss Sampson. We know that the disease is carried by the seed in certain species, notably *Festuca rubra* and *F. ovina*; but so far it has never been demonstrated in the seed of cocksfoot (*Dactylis glomerata*), one of the most seriously affected grasses in Great Britain.

Dr. Millard gave an interesting account of broccoli canker (caused by *Phoma lingam*) in the West Riding of Yorkshire, where many small growers save their own seed and therefore run into trouble since the disease is seed-borne. These local strains have become infected, but they are suited to the district, and growers are loth to import recognized varieties from other parts of the country which often do not acquit themselves so well in Yorkshire. In order to clean up these local strains, Dr. Millard for some years has accepted from growers seed stocks which are freed from *Phoma* by immersing them for twenty-five minutes in a hot water bath at 50° C. Germination may be depressed a little but in practice this has not proved serious unless the seed was old. Stocks have been cleaned and propagated at Askham Bryan and handed back to the growers in a perfectly clean condition. The value of this service to the market gardener needs no emphasis

A case of seed-borne club root (*Plasmodiophora Brassicæ*) on swedes was described by Dr. L. G. G Warne, of Manchester. Dr. Warne was able to infect a clean sample of seed with washings from an infected one, a thing which has not been done before. We do not know how widespread seed-borne club root is and it probably does not occur very often, but the fact that the possibility has been demonstrated is of great interest to plant pathologists and gardeners generally.

An account of seed examination at the Pathology Laboratory of the Ministry of Agriculture and Fisheries, Harpenden, was given by Dr. A Smith, who explained that practically all the samples are from consignments intended for export to countries requiring a certificate of health based on an examination of the seeds.

More than four thousand samples were examined in the year covering 1939–40, the great majority being vegetable and flower seeds. The War has cut down this export considerably and few agricultural seeds are exported to countries requiring certificates. The main causes of rejection are *Ascochyta* in peas, *Septoria* in celery and parsley, and halo blight in dwarf beans, but occasional samples of other diseased seeds are encountered. The presence of *Ascochyta* in seed peas was responsible for the rejection of 23 per cent of all peas examined for export purposes between 1925 and 1943. Considerable rejections of peas for marsh spot have also occurred, but, since it has been realized that this is not a communicable disease, affected peas may be exported provided they are likely to give a sound plant. In the same period 23 per cent of all samples of celery seed have been refused certificates because of the presence of *Septoria* pycnidia on the seed. An even greater percentage of parsley has been so rejected, namely, 31 per cent. Comparative figures for halo blight (*Pseudomonas phaseolicola*) are not available, but in recent years the percentages rejected have varied from 5 per cent to, in one year, as much as 25 per cent of the samples submitted.

All seed-borne diseases are not recognizable from an examination of the seeds themselves nor can they all be detected on incubation. Some diseases, for example, certain bacterial and virus diseases, as well as certain downy mildews in the seed coat, must perforce escape detection. Freedom from these can only be assured by an inspection of the growing crops.

Among seeds examined for purposes other than export may be mentioned a sample of onion seed which showed the presence of *Botrytis Allii* as a seed-borne disease.

G. C. Ainsworth exhibited maps showing the world distribution of certain seed-borne fungi from the series of "Distribution Maps of Plant Diseases" now being issued by the Imperial Mycological Institute. He emphasized that seed-borne diseases are often a particularly suitable subject for legislation and this aspect was briefly discussed in connexion with fungi the range of which is, or is not yet, co-extensive with that of the host.

The importance of seed-borne diseases was stressed in an interesting discussion that followed the papers, and the meeting certainly proved successful in providing an opportunity for useful comment on this very topical problem. J. H. WESTERN.

IMPORTANCE OF POTATO VIRUS X IN THE GROWING OF POTATOES

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VIRUS diseases are estimated to cause a loss in Great Britain of one million tons of potatoes a year, and this in spite of the importation of large quantities of seed potatoes; for example, last autumn and winter the Government imported 400,000 tons of seed potatoes from Scotland and Ireland.

There are three potato viruses which are of importance from the grower's point of view; they cause leaf-roll, severe and mild mosaic respectively. The first two diseases are aphis-transmitted and are infrequent in the best seed-growing areas of Scotland, where the aphis vector is uncommon. When these diseases do appear, they are easily visible and can be eliminated by careful roguing. With regard to virus X, which gives rise to mild mosaic, the situation is different. This virus, which occurs in strains of varying virulence, is present in a very high proportion of the best Scotch seed potatoes, not excluding those with a Stock Seed certificate. It is indeed scarcely an exaggeration to say that all the Scotch stocks of Kerr's Pink are infected with virus X. With the exception of a few varieties of potatoes, notably King Edward and Epicure, together with one or two others of less commercial importance, which react with a necrotic disease (top necrosis), the disease caused by virus X is extremely mild and often consists only of a faint and transitory mottling of the leaves. It is impossible, therefore, to say by inspection alone whether this virus is present or not, except in the severer strains, and roguing cannot be relied upon to eliminate the virus.

All the evidence suggests that virus X is not insect-transmitted, but Loughnane and Murphy[1] have demonstrated that it can spread from diseased to healthy plants in the field by contact of the haulms. In view of the widespread distribution of this virus, however, it is possible that other means of spread exist, and co-operative experiments are now being carried out in different parts of England and Wales to investigate this question.

Although the majority of Scotch seed potatoes are considered healthy, they are not virus-free; for that, as we hope to show, is not the same thing at all. As we have mentioned already, it is not possible to say by inspection alone whether a given potato plant is virus-free. Several careful tests must be carried out under controlled conditions in a glasshouse before that conclusion can be reached. Briefly, the tests consist first of inoculation to various plant species which are particularly sensitive to the several potato viruses (indicator plants), and secondly of grafting to susceptible varieties of potato. If all these tests are passed successfully, then the potato plant in question can be pronounced virus-free; and here we may remark, incidentally, that very few Scotch seed potatoes will pass these tests.

Where then can virus-free potatoes be found? At the Plant Virus Research Station at Cambridge are nucleus stocks of all the commercially popular potato varieties which have been grown in insect-proof glass-houses and rigorously tested for virus infection each year. These stocks were originally built up by Dr. R. N. Salaman, and since his retirement in 1939 they have been carried on and added to by us. There are, therefore, available small stocks of these potatoes which are definitely virus-free, including such varieties as Kerr's Pink and Up-to-Date which cannot be obtained elsewhere in this condition

Obviously, however, such nucleus stocks are not going to benefit the seed potato trade unless they can be increased to an extent not possible with glasshouse culture This multiplication is now being undertaken in co-operation with the National Institute of Agricultural Botany, and the procedure is as follows. the nucleus virus-free stocks of some twelve popular varieties were planted and grown under expert supervision in the best seed potato districts of Northern Ireland. As soon as a sufficient bulk of tubers was raised, the next step was to grow them in still more complete isolation. This has been achieved by planting the tubers on a small island—Islay by name—off the west coast of Scotland, where no other potatoes are grown It is hoped that in about two years time several thousand tons of virus-free seed potatoes will be available.

Periodically samples of tubers are returned to Cambridge from Ireland for re-testing, and in 1944 1500 tubers which had been grown out of doors for three seasons were tested. Of these the great majority was still virus-free, though a few tubers of a particular line of Majestic potatoes were X-infected. We have reason to believe that some of these Majestic tubers might have been already infected before their dispatch to Ireland. This stock of Majestic was discarded It seems clear from this and other experimental work that virus X spreads very slowly in the field; potato virus workers in Eire[2] have maintained certain potato stocks free of virus for several years by growing the plants in isolation and out of contact with each other.

RESULT OF ANALYSIS FOR VIRUS CONTENT OF EIGHT VARIETIES OF SCOTCH STOCK SEED POTATOES

Variety	No of tubers tested	No of X-infected tubers
Arran Peak	Four	One
Arran Victory	Twelve	Twelve
Eclipse	Thirty-six	Thirty-six
Gladstone	Four	None
Great Scot	Nine	Nine
Kerr's Pink	Twelve	Twelve
Majestic	Fifteen	Five
Sharpes' Express	Twelve	Four

It should be noted that these tubers were from plants specially selected as healthy by a competent potato inspector in an attempt to increase the virus-free stocks at Cambridge

Since the visible effects of the mild strains of X, which are the commonest, are so slight, the question may rightly be asked whether it is worth while to raise and maintain virus-free, and particularly X-free, potato stocks. In other words, does infection with virus X reduce the yield? This is the whole crux of the matter. Scott[3] in Scotland has carried out trials to investigate reduction of yield by virus infection. As his healthy control plants he used Stock Seed Certificate tubers and compared these with infected plants of four categories: (1) negligible mottle; (2) mild mosaic; (3) border-line severe mosaic; (4) severe mosaic. Scott's results showed that the least severe infection—negligible mottle—reduced the yield by about 13 per cent as compared

with his 'healthy' plants Since it is probable that Scott's healthy plants were also X-infected (see our analysis of Stock Seed tubers), what he was actually doing was correlating reduction in yield with severity of symptoms. The question that really needs answering is: Does the presence of virus X in a given potato variety materially reduce the yield when there is little or no visible adverse effect upon the plant itself? There seems little doubt that there is a considerable reduction in yield. Bald[4] in Australia has published some results of experiments on these lines He made yield trials on Up-to-Date potatoes, grading the severity of strains of X present in twenty-five families on the basis of their symptoms on an indicator plant (*Datura*) Bald estimated that the yield from completely healthy plants should be some 12 per cent higher than that from plants infected with the mildest strains of virus X.

Taking advantage of the opportunity offered by the 1,500 tubers from Ireland previously mentioned, all of which had been tested and found to be virus-free, a comparatively extensive yield trial was carried out at Cambridge The potatoes used consisted of one early variety, one second early, three early main crops and four late main crops.

The potatoes were planted in sixty plots, each of four rows of ten half-tubers, and the middle two rows only of each plot were weighed on sampling. As soon as the plants were six inches above ground, half the plants were inoculated with a very mild strain of X derived from some Stock Seed Arran Peak potatoes. This strain of virus was deliberately chosen for its mildness and was by no means the most severe of those isolated from tubers having a Stock Seed certificate

Some weeks later, twenty-five of the inoculated plants were selected at random and tested for the presence of virus, and all gave a positive reaction for virus X. It thus seems fair to assume that the inoculations had been effective, although it was not possible during the summer to pick out the inoculated plants by inspection.

On harvesting and weighing the tubers, it was found that the yield from the inoculated plants was 12 per cent below that of the virus-free plants, a difference which is highly significant. All the varieties showed reduction in yield from infection by virus X, but the data are not sufficient to differentiate varietal reaction with certainty. During the season, 105 of the healthy plants which were afterwards harvested were tested and found to be still virus-free.

These results seem to prove that infection with virus X, even with those strains which are normally passed over by the Scotch potato inspectors, results in a considerable loss of crop.

What evidence we have suggests that the elimination of potato virus X from the Scotch seed potatoes is by no means impossible Since it appears that the spread of virus X in the field is slow and there is little evidence of its infiltration into a crop completely free from the start, the solution apparently lies in a gradual replacement of the X-infected Stock Seed, and in this process we hope that the stocks built up by the Plant Virus Research Station in conjunction with the National Institute of Agricultural Botany may play their part.

[1] Loughnane, J. B., and Murphy, P A, *Sci Proc Roy Dublin Soc*, **22**, 1 (1938).
[2] Clinch, P., Loughnane, J B, and Murphy, P A, *Sci Proc Roy. Dublin Soc*, **22** 17 (1938)
[3] Scott, R. J, *Scott J Agric.*, **23**, No 3 (1941).
[4] Bald, J. G., *Aust. Coun Sci Indust Res Bull* 165 (1943)

SOIL CONSERVATION IN THE BRITISH COLONIAL EMPIRE

A RECENTLY published article, "Soil Erosion and Soil Conservation in the Colonial Empire" by H. A. Tempany, G. M. Roddan and L. Lord (*Emp J Exp. Agric.*, 12, 121, 1944), brings the story of soil conservation in the British Colonies up to date. Much of the story is by now well known, and should be still better known, for it concerns closely the future welfare and sometimes the very existence of British Colonial territories The menace of soil erosion has perhaps been somewhat exaggerated in the past, if so, it has been done with good reason, for the action necessary to remove the menace has only been taken after the people and more particularly the government authorities in London and the Colonies were thoroughly aroused by fear of catastrophe. Soil erosion is still prevalent and increasing throughout Africa, Ceylon, the West Indies and the Mediterranean Dependencies, but the fear of it seems to be abating. It has been shown that erosion can be controlled by apparently simple measures. As yet there are few areas where it has been completely controlled, but the knowledge that it can be has engendered confidence that it will be, and there is a tendency now to play down the menace, which in fact is neither greater nor less than it was.

The War has had a certain, not entirely unfavourable, influence on the progress of soil conservation. It has seriously depleted staffs and held up the construction of anti-erosion works which are often urgently needed; but at the same time it has helped to eliminate one of the root causes of soil depletion and erosion, namely, agriculture for export in a world market. The immediate effects of the War on soil-conservation programmes have undoubtedly been serious, but the long-term effects in promoting a change in methods of land utilization may be beneficial.

Many Colonial administrations now take a direct part in soil conservation, either through government-operated soil-conservation boards or committees, or by propaganda, education and the granting of subsidies for anti-erosion work. An important function of government is to promote co-operation between different departments (for example, of agriculture, forestry, public works, etc.), for soil conservation is the concern of the whole community. The authors give several instances where such co-operation is being realized with great advantage to the land. An important recent factor has been the provision of money from the Imperial Treasury through the Colonial Development and Welfare Fund for soil-conservation works.

Short accounts are given of the state of erosion and of the counter-measures being taken in each of the Colonial dependencies. The first impression given is that soil conservation is much the same everywhere. The following quotation refers to Basutoland, but the words are repeated with little variation in describing conservation measures in most of the other Colonies.

"The measures adopted comprised the laying out of contoured, broad-based terraces and the introduction of ploughing along the contour, the construction of earth-dams to check gully erosion and provide additional water-supplies for stock, combined with the planting of grass and trees to stabilize

contour banks and to assist the silting up of gullies, and the fencing of the banks of dams and of plantations to prevent damage by live stock . .

"Combined with these measures there must be improved methods of agriculture based on the introduction of mixed farming in place of the existing system. It is considered that the maintenance of crumb structure in the soil should be the aim and that this can only be maintained by suitable agricultural methods".

Many of the Colonies are still at the early contouring stage of soil conservation, at which the most urgent need is to construct mechanical barriers to run-off water and eroding soil. Some have reached the 'strip-cropping' stage, where contour cultivation is combined with an appropriate variant of ley farming, with the purpose of maintaining a crumb structure which will enable the soil to resist erosion with less absolute reliance on engineering constructions Particular note may be taken of the remarkable success in restoring soil condition and fertility on exhausted land, achieved in Uganda by strip-cropping with elephant grass. Simultaneously, and not only in Uganda, local inhabitants are increasingly appreciating the value of livestock as an integral part of farming and not merely as a symbol of wealth.

Throughout the British Colonial Empire, agriculture is evolving at an accelerating pace from primitive, shifting cultivation to settled, intensive systems. There is danger now, as there has been always, that evolution may get out of hand ; but at least we know what the goal is, we can even define it in terms of the physical properties of a fertile, erosion-resistant soil, and we know what agricultural operations will or will not advance the goal. The task of the future will be to synthesize the separate favourable operations into workable systems of land use The engineering problems of soil conservation have been solved ; the agricultural problems are well on the way to solution ; and last, but by no means least, the complex social problems still remain to be solved.

OBITUARIES

Sir Charles Vernon Boys F.R.S.

CHARLES VERNON BOYS was born at Wing in the county of Rutland on March 15, 1855, the son of the Rev. Charles Boys. Wing continued to be his home for many years, and it was in his father's garden there that Boys thirty-three years later made with his radio-micrometer his well-known experiments on the heat received from the moon and stars.

At the beginning of his delightful little book on "Soap Bubbles and the Forces which Mould Them", Boys tells how his interest in science was first awakened. "To G. F. Rodwell, the first Science master appointed at Marlborough College, this book is dedicated by the author as a token of esteem and gratitude, and in the hope that it may excite in a few young people some small fraction of the interest and enthusiasm which his advent and his lectures awakened in the author, upon whom the light of Science then shone for the first time."

From 1873 until 1876, Boys was a student at the Royal School of Mines. In his Guthrie Lecture, delivered before the Physical Society of London in 1934, he mentioned that he was for a short time at a colliery, and that he was brought back to South Kensington by Guthrie, who made him his private assistant and gave him a life membership of the Physical Society. His connexion with that Society always remained a close one, he succeeded Guthrie as its demonstrator in 1886 and continued to be its demonstrator and librarian until 1898, he was later to become its president and was its second Duddell medallist. It was to the Physical Society that much of his work was communicated, including his first paper on "A Condenser of Variable Capacity and a Total Reflection Experiment". This was published in 1879, and in the title Boys is described as "Lecturer for the term on Natural Science at Uppingham School". In this and the following year papers were published by Boys and Guthrie on "Magneto-electric Induction" and by Boys himself "On an Integrating Machine" The latter was the first of many papers dealing with practical mathematics, including one on "An Elliptograph" published in his eighty-ninth year

Boys was demonstrator of physics at the Royal College of Science, South Kensington, from 1881 until 1889, when he became assistant professor. Much of the work for which Boys is best known was carried out or begun during the years 1887–90 A preliminary note on the radio-micrometer was communicated to the Royal Society on February 24, 1887. In the tests of the method there described, he had used spun glass for the suspension of his radio-micrometer. In a note added a month later, he states that he has since found a method of producing fibres immensely superior to those of spun glass. These fibres of fused quartz obtained by his bow-and-arrow method were described in a paper, read before the Physical Society a little later in the same year, on the production, properties and some uses of the finest threads. The many uses of threads of fused quartz made possible by their perfect elasticity and great strength are there pointed out. An account of the perfected radio-micrometer was given to the Royal Society in the following year. He found a suitable application for the instrument in an investigation "On the Heat of the Moon and Stars", begun in September 1888 and published in the *Proceedings of the Royal Society* two years later Boys found the radio-micrometer amply sensitive for the comparison of the heat received from different small areas of the moon's surface ; it gave no certain indication of any heat received from even the brightest stars, although able to detect the heat received from a candle flame more than a mile away.

In 1889, Boys communicated to the Royal Society his ideas on improvements in the Cavendish experiment to determine the constant of gravitation, pointing out the advantages of reducing the scale of the apparatus ; the use of a fibre of fused quartz for the suspension made it practicable to carry this reduction very much further than would otherwise have been possible. Boys' final measurements of the Newtonian constant of gravitation were carried out in the Clarendon Laboratory, Oxford, and published by the Royal Society in 1894. He had succeeded in reducing the length of the torsion rod from which the attracted masses were suspended from the six feet of the original Cavendish experiment to less than one inch, the measurement was more accurate than any previously made of the constant of gravitation.

From indications which he had observed of the high electrical insulating power of quartz fibres, Boys was led to make investigations on quartz as an insulator, which were published in 1890. Besides proving the great merits of quartz as an insulator,

these experiments gave very strong indications that some at least of the leakage of electricity from a charged body suspended in a closed vessel is not through the insulating support but by conduction through the air.

An account of experiments with a soap bubble was given by Boys to the Physical Society in 1888, and in December 1889 and January 1890 he delivered the Christmas Lectures before a juvenile audience at the Royal Institution, which formed the basis of his well-known book on soap bubbles referred to at the beginning of this notice. In this subject Boys found ample scope for the exercise of his wonderful ingenuity and manual dexterity.

Notes on photographs of rapidly moving objects and on the oscillating electric spark formed the subject of a communication to the Physical Society in 1890. He gave a popular lecture at the Edinburgh meeting of the British Association in 1893 in which he showed photographs of rifle bullets in flight and the air waves accompanying them In a note communicated in 1937 to the Royal Society of Edinburgh, of which he had recently been elected an honorary fellow, he directs attention to the high speed of rotation given to a mirror by very simple means in these early experiments. He had used the rotating mirror to measure times as short as one hundred millionth of a second, and by its aid had found how to get an illuminating spark which lasted for only one thirteen-millionth of a second.

It was in 1888, in the midst of this wonderfully active period of his scientific life, that Boys was elected a fellow of the Royal Society; he was awarded a Royal Medal in 1896 and the Rumford Medal in 1924.

In 1897 Boys became one of the Metropolitan gas referees. He greatly improved the methods of gas calorimetry, and the calorimeter described by him in the *Proceedings of the Royal Society* in 1903 was adopted as the standard instrument for testing London gas; it came into general use in gas-works throughout Great Britain. He devoted much thought during many years to the planning of a still better gas calorimeter; but it was not until 1934 that he finally arrived at a design which completely satisfied him. This was described in his Guthrie Lecture of that year. Boys tells in this lecture that the idea underlying one important part of the mechanism came to him in a dream. "I was sufficiently impressed by it to get up at six and go to Victoria Street, where I blew in glass the bulb and tube you now see". He was then in his eightieth year.

It is not surprising that Boys, after his experiments with electric spark discharges, should take an interest in the development of a lightning discharge. With the object of investigating this subject, of finding, for example, at what part of its path the discharge begins and the speed with which it extends itself, he constructed in 1900 a moving-lens camera, of which he gave a short description in *Nature* of November 20, 1926. Although he was in the habit of carrying this camera about with him, it was not until twenty-eight years after its construction that, while staying with Loomis in America, he succeeded in getting his first photograph which showed the progressive development of a lightning discharge. Boys must have been interested in lightning for at least half a century when this photograph was taken, for in the issue of *Nature* mentioned above he gives a most interesting account of observations of a distant thunder cloud which he had watched at Wing in 1876. For every flash seen in the rain cloud or below, and simultaneously with it, one or more very slender flashes of typical lightning (in one case as many as seven) were observed to shoot upwards into the clear sky.

In spite of the handicap of the loss of one eye and very defective vision in the other, Boys continued his varied scientific activities until the end of his long life; when he was eighty he published little books on the natural logarithm and on weeds. It was in this year that he received his knighthood.

Boys does not appear to have been greatly interested in theoretical physics. His delight was in designing, constructing and manipulating apparatus for physical measurements of the highest accuracy, and in overcoming experimental difficulties which to most would have seemed insuperable. He was a really great experimenter, and his methods of working were original and often unconventional. He appears to have been equally original and unconventional in ordinary life

Boys married in 1892 Marion Amelia, daughter of the late Henry Pollock, and they had one son and one daughter, the marriage was dissolved eighteen years later.

Boys died on March 30, 1944, in his ninetieth year.

C. T R. WILSON.

Mr. J. A. Gaunt

NEWS has recently reached Great Britain of the death of Mr. J A. Gaunt on January 4, 1944; he died from myelitis as a prisoner of war in Hong Kong.

Gaunt entered Trinity College, Cambridge, from Rugby as a scholar in 1923, and had a distinguished undergraduate career, obtaining a mark of distinction in the Mathematical Tripos in 1926 and sharing the newly instituted Mayhew Prize. He then started to work on theoretical physics under the late Sir Ralph Fowler and soon became one of the most promising members of the rapidly expanding school which was being established at Cambridge in the latter half of the 1920's.

Gaunt's first paper was on the stopping power of matter for α-particles and was completed by March 1927. He next turned to statistical mechanics and extended some work by Fowler and by Eddington on stellar atmospheres. For this work, published under the title "The Debye-Huckel Theory and Stellar Atmospheres" (*Mon. Not. Roy. Ast. Soc.*), he was awarded a Rayleigh Prize in 1928. He then returned to the more congenial topic of quantum mechanics and wrote a number of short papers in rapid succession on such subjects as the theory of Hartree's self-consistent field and the relativistic theory of an atom with many electrons.

These early papers of Gaunt's were useful contributions to a rapidly growing subject, but his most important work is contained in two long and rather formidable papers published in the *Phil. Trans.* during 1929 and 1930, the first being on the triplets of helium and the second on continuous absorption.

The problem of calculating the triplet separations in helium was first tackled by Heisenberg, using non-relativistic quantum mechanics. The calculation is more difficult for helium than for heavier elements, since for helium the usual approximate theory is inadequate, retardation and other relativistic effects being of comparable importance to the spin-orbit and spin-spin interactions. When Dirac's relativistic theory of the electron appeared it was possible to

extend Heisenberg's work, and Gaunt was first in the field. His work has been superseded by that of others, notably by that of Breit, based upon a more thoroughgoing derivation of the fundamental equations from quantum-electrodynamics, but Gaunt made a very substantial contribution to a difficult problem.

In the 1920's the calculation of the absorption coefficient of matter for radiation was of great importance in astrophysics. Kramers' formula, based upon the old quantum theory and the correspondence principle, was in violent disagreement with the value of the absorption coefficient required according to the current astrophysical theories. It was therefore of considerable importance to calculate what the absorption should be according to wave mechanics. This was first done by Oppenheimer, who obtained a formula substantially different from Kramers'. Gaunt, who was working on the same problem, discovered an important mistake in Oppenheimer's calculations and rehabilitated Kramers' formula. He also extended Oppenheimer's work considerably

These two long papers were completed in little more than twelve months work, and show Gaunt's great ability to handle complicated mathematical problems. It is remarkable that Gaunt should have been able to achieve so much in a single year, since he had already determined to give up theoretical physics for what he considered to be more important work. He was elected a research fellow at Trinity in October 1929, but never resided. Instead, he left England and went, under the auspices of the Church Missionary Society, as an assistant master at St. Stephen's College, Hong Kong, where he taught mathematics, English and Scripture to Chinese and Siamese boys. He acquired a good knowledge of Chinese, and his pupils liked and admired him, but were genuinely perplexed how a man of such ability came to be their teacher.

Gaunt never lost his interest in physics and found time to read such papers as were sent out to him by friends. Music gave him great pleasure, as did the opportunities he had for travel in China, especially in the mountainous regions. When the shadow of war hung over the Colony, Gaunt joined the Volunteer Defence Corps as a gunner, and took part in the brief struggle.

Gaunt was somewhat reserved with most people, but he had a strong sense of humour and a ready sympathy in the everyday affairs of life. It must have cost him much to make the sacrifice of going to China, but it was done with perfect cheerfulness, in obedience to his conviction of the supreme importance of Christianity.

A. H. WILSON

WE regret to announce the following deaths:

Prof. R. Bennett Bean, professor of anatomy in the University of Virginia during 1916–41, known for his work on the distribution, development and evolution of man, on September 3, aged seventy.

Lieut.-Colonel J. W. F. Brittlebank, C.M.G., president of the Royal College of Veterinary Surgeons during 1926–28, on December 18, aged sixty-eight.

The Rev. E Tickner Edwardes, well known for his popular writings on bees and on general natural history, on December 31, aged seventy-nine.

Dr. J. Fitch King, professor of chemistry in Williams College, Williamstown, Massachusetts, on August 29, aged forty-nine.

NEWS and VIEWS

Prof. A. N. Whitehead, O.M., F.R.S.

THE award of the Order of Merit to Prof. A. N. Whitehead, of Harvard University, announced in the New Year Honours, will be widely acclaimed. Prof. Whitehead was first known as a mathematician, though of an unusual kind Mathematics for him meant the "development of all types of formal, necessary, deductive reasoning" (preface to "Universal Algebra", 1898). This phase of his career culminated with the publication of "Principia Mathematica" (1910–12). It was afterwards, as most of us thought, that he turned to philosophy—with a remarkable contribution to the theory of knowledge in 1919–20, and later with a complete system of metaphysics expounded in a series of well-known works. It has been pointed out by Prof. V. Lowe (essay in "The Philosophy of A. N. Whitehead", 1941) that there was no sudden change; the philosopher was implicit in the mathematician, as could be seen in a paper of 1905.

Whitehead's later works have been much read and quoted—often misread and misquoted. That is the fate of a writer who is at times obscure, at times brilliantly epigrammatic. It is characteristic of his attitude to emphasize the need for abstract thought and also the fallacies that arise from it; the need for rule and order in life and also that mere order means futility. Whitehead's essays on the aims of education are too little known. Nobody has argued more persuasively for the value of history in education. As is more widely known, few have viewed human history with so keen and comprehensive an eye, and so wide and fine a sympathy.

Organization of Science in Great Britain

AN interim memorandum from the sub-committee on the future scope and organization of science in Great Britain which has been issued by the Parliamentary and Scientific Committee urges as an immediate measure the appointment by the Government of a committee, with the widest powers of securing information, to review the existing position of industrial research and development in British industry, and to plan a programme (covering, say, the next five years) aimed at remedying the most important defects and gaps in that field, so far as the national interest is concerned. Such a review would involve consideration of existing national resources at home, the probable economic position of Britain in the post-war world, and the lines along which the immediate, vigorous and large-scale application of scientific knowledge is likely to yield the most fruitful results. In this connexion the sub-committee stresses the necessity for special attention to scientific research on the treatment of coal. The review would also involve investigation into the points at which British industry in general, and certain industries in particular, have failed in the past to utilize scientific knowledge, the loss to the national interest which has resulted from this failure and the steps which

can be taken to prevent the recurrence of similar failure. The sub-committee does not consider that a review of this type, involving specialized technical knowledge of a number of different industries, combined with a particular appreciation of the facts affecting the position of Great Britain in the world economy, could be adequately carried out by any existing agency. While the proposed committee should take its evidence in secret, an early and informative report is regarded as essential, first as a means of bringing home to industry and the public the realities of the existing situation, and secondly, to afford a basis for settling the plan of action required to recover and maintain the industrial strength upon which our future as a nation depends.

Newton and His Portraits

MR. F. E. BRASCH, of the United States Library of Congress, has selected some of the best portraits of Newton for publication in *Scripta Mathematica* (8, 199; 1941). The earliest is by Sir Peter Lely, and is supposed to show Newton (who was born on Christmas Day, 1642, Old Style) as he appeared in 1665 (the year of the Great Plague), but there is grave doubt whether Newton sat for this. The first portrait that can be guaranteed authentic is by Sir Godfrey Kneller, and is dated 1689, two years after the publication of the "Principia". The other portraits all show Newton as president of the Royal Society, a position he held from 1703 until his death in 1727. One is by William Gandy (1706), four by Johann Vanderbank (1720, 1725, 1726 and 1726 again), and one by an unknown artist. There are also photographs of a bas-relief attributed to Wedgwood, of a bronze statue by the American sculptor C. E. Dallin (1897), and of the reconstruction in Wellesley, Mass., U.S.A. of the actual parlour from Newton's house in Leicester Fields, St. Martin's Street, London.

In another article (*Science*, 99, 437; 1944), Mr. Brasch gives us some information about the influence of Newton on Russian science. For some unknown reason, Newtonian ideas were ignored in Russia long after they had been accepted in France, Germany and other countries. Indeed, it was not until quite recently that the formal recognition of his work became evident. His "Optics" was translated into Russian in 1927, and the "Principia" in 1936. However, the celebrations of the tercentenary of Newton's birth left nothing to be desired. They were on an impressive scale, much exceeding those in Great Britain, and culminated in the founding of fifteen Isaac Newton studentships.

Texas Meteor Cloud

OSCAR E. MONNIG has described the effects of a fireball observed on May 20 over Texas (*Sky and Telescope*, September). It travelled from west to east and left a meteor cloud, photographs, some of which are reproduced, were taken by different people. Unlike some fireballs, this one did not leave a persistent train; two minutes after Ray Dudley, in the middle of Pampa, had taken a photograph, he was able to secure another one which showed a great change, not only in the brilliance of the meteor cloud, but also in the amount of diffusion that had taken place. The sun had set 40 minutes in some places and 20 minutes in others when it was seen, and as it was visible for a radius of more than 300 miles, it must have been a very imposing object at first. Atmospheric resistance slowed down its speed, which was almost below that of incandescence 13 miles north-west of Pampa. Attempts to find fragments of the fireball, which almost certainly disintegrated (though there is no record of a report due to disintegration such as is often heard with fireballs) have so far been unsuccessful, but it is hoped that some of the debris will be obtained. A provisional path has been computed, and it appears that it became visible at a height of 56 miles, the dense cloud being formed at a height of 23 miles (this latter is considered very accurate), and its direction of flight was at an angle of about 45° to the horizon.

Insect Pest Resistance in Plants

THE Imperial Bureau of Plant Breeding and Genetics, Cambridge, has issued a Bibliography on Insect Pest Resistance in Plants (1*s*. 6*d*.). The sources drawn upon include publications from the British Commonwealth, the main European countries, the United States and various South American countries, the U.S.S.R. and Japan. In all, there are more than 550 references arranged according to subject, the chief of these being cereals, roots and tubers, cotton, sugar-cane, fruits and vegetables. Nematodes are dealt with in a special section. Many of the publications included have been abstracted in *Plant Breeding Abstracts*, and in many instances the original publications cited are available at the Bureau or in some co-operating library, and further information can therefore, if necessary, be obtained on application to the Bureau. It is believed that the bibliography will be of practical assistance not only to the breeder and the geneticist, but also to all who are interested in the solution of the important problem of the fundamental basis of insect or nematode resistance among crop plants.

Poliomyelitis in Argentina

THE July issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an instructive article by Dr. G. Bayley Bustamante, assistant professor of public health, Buenos Aires, dealing with the last outbreak of poliomyelitis in the Argentine (October 1942–May 1943 with 1,948 cases). This was probably the largest outbreak, although epidemics were reported in 1909, 1911, 1916–17, 1919–20, 1924–25, 1932–33, 1934–35 and 1936, mostly in the Buenos Aires and Rosario Area, with smaller outbreaks and sporadic cases in the rest of the country; but paralytic cases figure in the statistics in 1941. There were 355 cases (189 in the Province of Santa Fé), which was an increase on the usual yearly figures. The 1942 epidemic in the southern suburb of Buenos Aires then extended into the city and to the rest of the province, with the peak in November and December; it increased along the coast after January and moved northward. The incidence was highest in the Buenos Aires sector. Half the cases were in children aged 1–3 and another 10 per cent in those less than 1 year. The death-rate ranged from 3·5 to 23–25 per cent, usually being 10 per cent. Of the eight large Argentine epidemics, four began in February and one each in June, September, October and November. The 1942–43 epidemic had its peak in October–November (spring); the year had been characterized by a hard but short winter, an early warm spring and a very hot and dry summer.

Leprosy in the Dominican Republic

ACCORDING to Dr. Guillermo Iliviera (*Bol. Of. San. Panamer.*, 22, 987; 1943), medical superintendent of the National Leprosarium of the Dominican Republic, 212 cases of leprosy have been treated there during the period 1922–42, or are still confined there. 142 were men and 70 women. There were 75 deaths and 23 births. 147 cases were from the southern zone, while 44 were from the northern zone; the central area was practically free from the disease. Estimating the total number of lepers in the Republic both in and out of the leprosarium at 224, one obtains a ratio of one leper per 8,500 inhabitants, which is much lower than that of India (1 per 3,000) and Japan (1 per 1,000).

Performance of Cable Terminations

IN a paper read by D. B. Irvin before the Institution of Electrical Engineers in London on November 8, the performance, over the period of twelve years ended 1943, of the cable terminations on the British Grid system at voltages between 3·3 kV. and 132 kV. is reviewed, and the causes of breakdown are examined. For the period under review, termination failures account for approximately 40 per cent of the total cable circuit faults and they are classified as follows: design 39, workmanship 2, design or workmanship 18, maintenance 9, and system conditions 12. Failures on 6·6, 11 and 33 kV. circuits predominate. The failures attributed to design and workmanship were mainly due to imperfect stress control, inadequate internal clearances, compound migration, and presence of moisture; the incidence of these is discussed in the paper. The fundamental characteristics required of a cable termination are: (*a*) ability to withstand the electrical stresses associated with normal and emergency conditions of the voltage of the system and the occasional high-voltage impulses to which it will be subjected in service; (*b*) ability to carry the maximum rated current of the circuit and the maximum fault current of short duration to which the circuit is liable; (*c*) retention of its initial electrical and mechanical qualities without deterioration, during the statutory life of the cable circuit in which it is incorporated; and (*d*) economic cost to the user. Sectional drawings are included showing improved designs of sealing ends for various sizes and types of cables for voltages ranging from 3·3 to 132 kV., and the salient features of these are discussed briefly.

Design of A.C. Turbo-Generators

IN a paper read by G. A. Juhlin on December 7, before the Institution of Electrical Engineers in London, on the standardization and design of A.C. turbo-type generators, the possibilities of complete unification of designs, an alternative of mechanical interchangeability, and the standardization of requirements, which is the first step in either of these directions, are considered in turn. The author discusses standardization of design, future development, and standardization of requirements, which latter is the really valuable part of the paper. The conclusions arrived at are that for both commercial and technical reasons complete unification of designs must be regarded as impracticable under present conditions, and it seems very doubtful whether the alternative of mechanical interchangeability would be feasible.

Announcements

DR. F. W. ASTON has been awarded the twenty-first Duddell Medal of the Physical Society, in recognition of his invention and development of the mass spectrograph.

PROF. G. M. BENNETT, University professor of chemistry at King's College, London, since 1938, has been appointed Government chemist in succession to the late Sir John Fox.

THE title of emeritus professor of geography in the University of London has been conferred upon Prof. E. G. R. Taylor, in recognition and appreciation of her distinguished services to the University and to her subject.

FOLLOWING on the recent appointment of Prof. J. A. Scott Watson as chief education and advisory officer to the Ministry of Agriculture and Fisheries, the Minister, in preparation for the setting up of a National Agricultural Advisory Service, has appointed the following senior education and advisory officers as from January 1: Mr. F. Rayns, Dr. W. K. Slater and Dr. H. V. Taylor. Mr. Rayns's appointment is on a part-time basis, and he will continue to act as director of the Norfolk Experimental Station, Sprowston He is succeeded as executive officer to the Norfolk War Agricultural Executive Committee by Mr. J. C. Mann, who was deputy executive officer of the Committee.

THE Therapeutic Research Corporation has elected the following officers for the year 1945: chairman of Board of Directors, Lord Trent (Boots Pure Drug Co., Ltd.), in succession to Mr. H. Jephcott (Glaxo Laboratories, Ltd.); deputy chairman, Dr. F H. Carr (The British Drug Houses, Ltd.); chairman of Research Panel, Mr. F. A. Robinson (Glaxo Laboratories, Ltd.), in succession to Dr. A. J. Ewins (May and Baker, Ltd.); deputy chairman, Dr. C. H. Kellaway (Wellcome Foundation, Ltd.), in succession to Mr. F. A. Robinson (Glaxo Laboratories, Ltd.).

IN view of the importance which civil air transport will assume after the War, the Council of the Institution of Civil Engineers has decided to form a sixth Engineering Division to be known as the "Air Transport Division", to deal with such aspects of air transport as airports (land and sea), airfields, operational buildings and facilities, hangars, and signalling and other appliances in connexion with safety in flying. Until such time as a fully constituted divisional board has been elected, Mr. M. G. J. McHaffie has been appointed chairman of a provisional board.

THE twenty-seventh election to Beit Fellowships for Scientific Research will take place on or about July 7, when not more than three fellowships will be awarded. Candidates may be of any nationality but must be of European descent by both parents; and must be of university degree standing. Forms of application and all information may be obtained, by letter only, addressed to the Registrar, Imperial College, South Kensington, London, S.W.7, to whom they must be returned on or before April 6.

AT a meeting of the Physical Society to be held at the rooms of the Royal Society on January 19 at 5 p.m., a lecture on "Imperfections of Crystal Lattices as investigated by Study of X-Ray Diffuse Scattering" will be delivered by Dr. A. Guinier, of the Laboratoire d'Essais, Conservatoire National des Arts et Métiers, Paris.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Dextran as a Substitute for Plasma

As is well known, we have in blood, plasma and serum adequate media for the treatment of shock, for example, in cases of serious loss of blood or contusions. During the present War, however, it has proved impossible completely to supply the large requirements of these materials. It is therefore natural that physiologists and chemists are seeking for substances the aqueous solutions of which can replace the expensive and delicate blood or plasma.

In the course of the War of 1914–18, Bayliss[1] attempted to employ solutions of gum arabic for purposes of infusion. Later, other substances such as gelatin, polyvinyl alcohol, pectin, polyvinylpyrrolidone and others were tested to this end. The infusion of these colloids has, however, been attended by certain difficulties. Some of the substances tested have antigenic properties, whereas others cannot be broken down by the organism, for which reason they are stored in the organs, especially in the liver

The conditions to be fulfilled by a foreign colloid in order that it may exercise a therapeutic effect in cases of shock are, in brief, as follows:

In all cases of shock, both in bleeding and in contusions and burns, it is essential to increase the volume of the circulating blood by the infusion of a liquid. This cannot be done satisfactorily with solutions of crystalloids. The infused liquids must instead contain colloids that exert the same colloidal osmotic pressure as the plasma proteins, or 300–400 mm. water. A condition for the exertion of this pressure by the colloids is that they must be of such a molecular size that they cannot pass through the walls of the capillaries

The colloid must be suited to repeated intravenous injection in large quantities. It must also be completely atoxic and devoid of antigenic properties.

The solutions must not have a high viscosity. The viscosity should preferably be of the same order as that of the blood.

Finally, the substance should be of such a nature that the body can gradually rid itself thereof, so that it does not remain long in the blood and is not stored in the organs.

A substance not previously tested for this purpose and apparently fulfilling the requirements listed above is the neutral polysaccharide dextran. Dextran is a water-soluble high-molecular carbohydrate which is formed in solutions of sugar infected with the bacterium *Leuconostoc mesenteroides*. It has been possible to show that the dextran molecule is built up of glucose units, linked together in long, more or less branched chains[2]. The molecular weight of dextran may be very high, of the order of magnitude of many millions[3,4,5]. By partial hydrolysis dextran preparations of lower molecular weight, for example, of the order of 100,000–200,000, can be made[6]. The partially hydrolysed dextran, like the original substance, is inhomogeneous with respect to molecular weight.

By well-controlled partial hydrolysis it is possible to prepare dextran solutions for purposes of infusion in which the solute has a suitable molecular weight and which do not give rise to injuries or reactions even after repeated large infusions. The sedimentation reaction, however, is increased after infusion (which has also been observed after infusion of, for example, gum arabic). The viscosity and colloidal osmotic pressure of the 6 per cent solutions employed (with 1–3 per cent sodium chloride) are of the same order as those of blood[6,7].

The solutions can be autoclaved and the preparation distributed in concentrated solutions or in the form of dry powder

If a normal infusion dose is injected intravenously into a dog, the dextran concentration in the blood falls to zero in the course of three to four days During the whole of this period dextran can be detected in the urine. The dextran ejected with the urine has a lower molecular weight than that originally injected Even after repeated large infusions, no storage in the organs can be demonstrated histologically[6,7].

As dextran is broken down by the organism, glucose and relatively low-molecular fragments of dextran are presumably formed, which can pass the kidney filter and be expelled with the urine.

The therapeutic effect was investigated experimentally in cases of shock from bleeding, histamine shock and contusion shock developed artificially in rabbits and cats Rapid and lasting effects on the blood pressure, heart action and respiration were always registered[6].

The experiments on animals giving favourable results, a clinical investigation was therefore commenced, at first on a limited scale. As the first clinical tests also gave promising results, and as there is reason for supposing that dextran is better suited as a plasma substitute than, for example, gum arabic, polyvinylpyrrolidone or pectin, it was considered justified to set in train a more thorough clinical investigation An account of this will be submitted at a later stage.

We wish to thank Prof. Arne Tiselius for helpful advice and Profs. T. Svedberg and A Westerlund for the provision of laboratory facilities. The research has been carried out with grants from A. B Pharmacia, Stockholm, and Svenska Sockerfabriks A.B., Malmo.

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Reactivity of the Sulphur Linkage in Wool

WHEN a wool fibre is rubbed lengthways between finger and thumb, it migrates in the direction of the root end because the surface consists of a series of overlapping scales. Similarly, when a fabric containing wool fibres is rubbed in presence of aqueous media, the fibres migrate and cause the material to shrink. Such shrinkage is usually prevented by treating the fabric with compounds which are capable of forming a gelatinous degradation product of keratin on or under the scales of the fibres. A survey

of the properties of these compounds suggested[1] that any reagent which is capable of causing disulphide-bond breakdown should make wool fabrics unshrinkable if it is applied under conditions such as to restrict its action to the surface of the fibres. Confirmation of this deduction has since been provided by the discovery of methods for conferring an unshrinkable finish on wool by means of sodium hydroxide[2], sodium sulphide[3], and alkaline solutions of mercaptans[4].

Further evidence that disulphide-bond breakdown is the essential cause of unshrinkability has now been obtained by comparing the action of chlorine, sulphuryl chloride and sodium hydroxide on untreated wool and wool in which some of the disulphide bonds are replaced by more resistant cross-linkages. The most simple method of preparing wool containing a large number of stabilized cross-linkages is by treatment with dilute sodium hydroxide solution in the cold for several hours. Some of the disulphide bonds are thereby replaced by $-CH_2-S-CH-$[5] and $-CH=N-$[6] cross-linkages, the presence of which is indicated by the fact that fibres (human hair) immersed in $0{\cdot}1\,N$ sodium hydroxide solution for six hours or more at 22·2° C. are incapable of supercontraction in boiling sodium bisulphite solution, whereas corresponding untreated fibres contract 23·8 per cent under similar conditions.

For the purpose of these experiments, therefore, two 2·5-gm. patterns of an all-wool flannel were immersed in 2 litres of $0{\cdot}1\,N$ sodium hydroxide solution for 10 hours at 22·2° C., the solution being renewed after the first five hours to prevent undue accumulation of sodium sulphide. After being washed in running water overnight, one of the patterns was removed and treated with 4 per cent chlorine (on the weight of the wool) in a buffer solution at pH 4. The fabric was then treated with 1 per cent sodium bisulphite solution, neutralized with 0·5 per cent sodium bicarbonate solution, and finally washed in running water overnight. An untreated pattern of flannel was chlorinated in the same way, and the three patterns, with a sample of untreated flannel, were milled together by hand in 5 per cent soap solution. The resulting shrinkages are given in the accompanying table, which includes corresponding data for 2·5-gm. patterns treated either for 1 hour at 22·2° C. with 100 c.c. of a 2·5 per cent (v/v) solution of sulphuryl chloride in carbon tetrachloride, or for three hours at 22·2° C. with 10 c.c. of a 7 per cent solution of sodium hydroxide in butyl alcohol made up to 100 c.c. with white spirit.

Treatment	Percentage shrinkage in area of patterns treated with 0 1 N sodium hydroxide for ·	
	10 hours	24 hours
Untreated	30 6	31 7
Chlorinated	9·2	4 3
Sodium hydroxide	26·4	27·5
Sodium hydroxide and chlorinated	20·7	18 0
Untreated	30·8	32·6
Sulphuryl chloride	5·9	−0·9
Sodium hydroxide	27·1	26 8
Sodium hydroxide and sulphuryl chloride	26 8	13 0
Untreated	36·3	37·9
Sodium hydroxide dispersion	5 1	3·5
Sodium hydroxide	28 1	27·7
Sodium hydroxide and the sodium hydroxide dispersion	15·6	24·4

A second series of experiments was carried out with patterns which had been treated with $0{\cdot}1\,N$ sodium hydroxide solution for 24 hours at 22·2° C., with renewal of the solution after ten hours treatment. In all cases, the shrinkages are based on the wetted-out areas of the patterns immediately before milling.

The ability of the fabric to acquire an unshrinkable finish is reduced very considerably by previous treatment with $0{\cdot}1\,N$ sodium hydroxide solution, even though all the disulphide bonds of the wool are not converted into more resistant cross-linkages. It must, therefore, be concluded that disulphide-bond breakdown is the main, if not the only, cause of the unshrinkability imparted to wool by chlorine, sulphuryl chloride and sodium hydroxide. The results have the further importance of revealing that strict control of those operations in which wool is exposed to the action of alkalis, notably in scouring, is essential if satisfactory and reproducible results are to be obtained in practice with the above reagents.

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The Food Finding of Wireworms (*Agriotes* spp.)

THE apparent efficiency with which wireworms (*Agriotes obscurus*, *lineatus* and *sputator*), when in an active feeding phase, find crop plants on which to feed is very striking. It is displayed even though these plants may not be particularly closely spaced and at first occupy only a very small proportion of the total soil surface. This makes it appear improbable that random wandering either on or in the soil could offer a complete explanation. Yet in spite of this, and of the enormous literature on wireworms, there seem to be no studies on record which throw any clear light on the methods by which the food is found. The potential importance of such knowledge as a basis for the elaboration of trapping methods needs no emphasis, and it was largely for this reason that the work here described was undertaken. It is hoped that the first paper dealing with these investigations will shortly be in the press. The object of this letter is to summarize certain broad conclusions which have so far emerged.

It is now well established (see D. S. Falconer[1]) that wireworms under suitable conditions of temperature and humidity will come up to wander on the surface of the soil. Accordingly, preliminary investigations with olfactometers of various types were made. No evidence was found that wireworms are capable of orientating themselves to the air-borne odours of favoured food plants. This being so, work proceeded on the assumption that wireworms can orientate themselves in the soil by means of some substance or substances emanating from plant roots or other tissues and dissolved in the soil water.

Responses of wireworms in the soil were investigated by means of two types of apparatus, one which tests

the biting reaction and the other a soil choice chamber which tests the ability of the animals to aggregate in solutions or suspensions of test substances in sand or soil. In the first apparatus the number of bite marks on a series of baited filter papers, compared with those on a control set exposed simultaneously, gives a numerical measure of the biting response to a given substance or extract. In the second apparatus the figure obtained is the number of wireworms aggregating in a given time under constant temperature conditions in one of the compartments of the choice chamber. All the aggregation tests mentioned in the present communication were carried out in sand. By means of these methods it was first shown that extracts of potato, carrot, beet and other food plants will cause wireworms to aggregate or to bite or both. *A. lineatus* and *A. obscurus* cannot be distinguished in the larval stages; but no differences have yet been found between the responses of these species and those of *A. sputator*.

Aggregation and biting are apparently distinct responses and are elicited by different classes of chemical substances as follows. Biting is elicited by sugars, fats and polypeptides and also to some extent by tannin and polyhydric alcohols. If one gram of a substance is dissolved in x c.c. of water to reach the threshold of either biting or aggregation, then the 'activity' of that substance is defined as $\log_{10} x$. The activity of sucrose was found to be 2. The number of bites made on a given area of filter paper soaked in 2 per cent glucose formed a roughly normal curve when plotted against pH. The maximum (40 wireworms, 24 hours, 23° C.) was approximately 1,000 at pH 6–8, falling to 0 at pH 0 and 14. The threshold was not affected by pH.

Aggregation was first studied by observing the response of wireworms to pure sugars. The sugars examined were found to have an activity of 2, the same as that for biting. The aggregation reaction to a plant extract was analysed in the following way. Potatoes were ground and the juice pressed out, spun to remove starch grains and filtered through kieselguhr. The activity of this juice was 6. The sugars in the juice, found to be 1 per cent, would only account for an activity of 0 on a logarithmic scale, so that some other active substance or substances must have been present. After boiling and filtering, followed by boiling with 2·5 per cent of charcoal, a colourless protein-free solution of activity 6 was obtained. The addition of two volumes of alcohol gave a copious inactive precipitate, and a third volume precipitated colourless rhombic active crystals. These proved to be asparagine, which has an activity of 9. Glutamine has the same activity. The distribution of asparagine and glutamine in potatoes has been examined by A. Neuberger and F. Sanger[2]. The means of their results in six varieties are respectively 0·26 per cent and 0·21 per cent of the fresh weight. This range would account for our observed activity of the juice, whether the activities of asparagine and glutamine are additive or not. Aggregation is also caused by a variety of compounds related to asparagine, including aspartic acid 11 and malic acid 9. The lower fatty acids were found to be inactive but their amides are active.

The activity of all active substances falls suddenly to zero below the threshold concentration, above which there was no detectable response to a gradient. While sugars cause both reactions, some other active substances elicit only one of the responses; thus asparagine does not cause biting, nor triolein nor casein aggregation. There must therefore be at least two types of chemo-receptor, the stimulation of one of which leads to aggregation, and of the other to biting. The sensitivity of the former is comparable to that of olfactory receptors, for an activity of 11 means that the wireworms respond to a concentration of 1 in 10^{11}, while the sensitivity of the latter is similar to that found in organs of taste.

The finding of food by wireworms when in friable soil is probably in the main klinokinetic. This may be envisaged as follows. Wireworms show vertical movements in the soil governed by such factors as moisture content, temperature and season. In addition to this, when in an active feeding phase, they also wander at random in the soil. This may carry them into a region where active substances of plant origin are present in the soil moisture in quantity above the threshold. Their behaviour remains unaffected until they pass *out* of this region, when they show increased turning movements which would bring them back into it again—upon which they once more proceed through it. By this means they are kept within the favourable region, where their wandering continues until some substance which releases the biting response is encountered and feeding begins. This method of orientation, or something very similar to it, is well known for a number of invertebrates (Ullyott[3], Fraenkel and Gunn[4]); but so far as we are aware, this is the first instance in which it has been shown to operate in the food-finding of a soil-dwelling animal. The efficiency of the method in soil will, of course, depend on several factors which are now being studied, such as the rate of secretion of active substances by plant roots, the rate of their bacterial decomposition, the extent to which they are adsorbed on the soil particles, the texture of the soil and the magnitude of the water movements within the soil.

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Periodic Spawning of 'Palolo' Worms in Pacific Waters

THE Mbalolo, *Eunice viridia*, is a marine annelid found in several places in islands of the Western Pacific. In Fiji I know of two and have heard of a third place in which the periodic 'rising' takes place. One such spot is between the shore and the fringing reef at the village of Tokou, in the island of Ovalau.

Another is in the Yasawa islands off the north-west coast of Viti Levu, and I have heard that there are one or more spots in the Lau group, which forms the eastern limits of the Fiji Islands. It also occurs in the Samoan group, where it is known as Palolo; and probably elsewhere.

During my period as commissioner, stationed at Levuka, I have seen the 'rising' at Tokou on several occasions. Nearly every year there are two risings,

the first known as *Mbalolo lailai* (small Mbalolo) and the second as *Mbalolo levu* (large Mbalolo); 'large' and 'small' do not refer to the size of the worm but to the quantity of the worms. Occasionally there is no *Mbalolo lailai.*

In a normal year the *Mbalolo lailai* appears about the end of October and is followed by the second, and main, rising about two or three weeks later. The main rising always occurs at dawn, and, literally, the worm comes up with the sun. It is, also, always at the time of high water.

The worm, when it comes to the surface, is headless, and it is known that the head remains alive in the reef. The parts shed are from ten to fifteen inches long when they reach the top of the water and continue to wriggle.

There was an old Fijian living in the village of Tokou who was a foreteller of the day of rising, and I used to apply to him for information as to when I should take part in the event. To do so required some preparations: a boat and crew with dip-nets ready at the village; somewhere to sleep until about 04.00, when one had to prepare to move out, lanterns, torches and so forth. The information obtained from the prophet was not always reliable. On the other hand, my experience was that when he said he was certain, it was so.

The uncertainty occurred when the usual date—connected with the phases of the moon, no doubt—had gradually got further and further from the normal. Whatever the actual explanation of the date of spawning, the fact remains that the Mbalolo makes its annual rising at an approximate date by the calendar year but at an actual date by the moon and tide. When the difference becomes more than a few weeks, the date combines solar influence and the appropriate lunar and tide conditions. Records have been kept in Levuka, Fiji, for some seventy years, but I have not yet been able to have access to them.

To attend a 'rising' is an unforgettable event With the necessary preparations made, I have boarded my boat at 04.30 after a sleep in the village and paddled out to a position about half-way out to the main reef, which skirts the shore at this spot at a distance of about a mile. Then torches are shone into the water vertically from the boat's side to see if there are any indications. If it is the right day, small stray bits of the worm make their appearance, and nets are got ready. Then, when the first light of dawn appears, great funnels of worms burst to the surface and spread out until the whole area is a wriggling mass of them, brown and green in colour.

When the tropical sun rises perpendicularly from the sea the catch is in full swing, and hundreds of boats, canoes and punts are filling up kerosene tins and jars by the simple process of dipping them out with nets.

The worms also provide an annual feast for the fish; for all round and between the boats big fish and sharks cruise quietly along, gulping them in, and take no notice whatever of the boats or their occupants.

As the sun makes itself felt, a change begins to occur in the length of the worms. They begin to break up into shorter and shorter bits, until some three hours after sunrise the entire surface of the sea shows nothing more than patches of scum.

Mbalolo is rightly prized as very good eating and, if one can forget what it looks like before being cooked, is delicious. Fijians—and I have known Europeans to do likewise—eat some raw, when perhaps it may resemble oyster; I could never bring myself to try. In its raw state it is said to have a stimulating effect on fecundity The Fijians also say that a dish of it eaten in any form will protect a person from all sickness until the Christmas Day following.

A curious fact is that all fish caught in the neighbourhood of the rising are poisonous to human beings for about ten days or a fortnight after the event

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The C_{20} Unsaturated Acids of Animal Fats

ESTER-FRACTIONATION analysis of certain animal depot and milk fats has shown the presence of small amounts (1–3 per cent) of unsaturated C_{20} acids[1]. These acids have generally been regarded as highly unsaturated[2,3] and probably similar to the corresponding liver glyceride fatty acids. Experimental difficulties in purifying the residual ester-fractions (in which the C_{20} acids accumulate, along with polymerized or partially oxidized acids) have prevented more exact identification.

The amount of C_{20} acids determined from the polybromide number is, however, usually much less than the amount of C_{20} acids calculated from the saponification equivalent[4]. Recent work suggests that highly unsaturated acids constitute only a small part of the C_{20} unsaturated acids. Cramer and Brown[5], by crystallization of a C_{20} concentrate, provided evidence for the presence of C_{20} acids of lesser unsaturation than arachidonic acid in human depot fat. Baldwin and Longenecker[6] used the isomerization technique of Mitchell *et al.*[7] to indicate that human milk fat contains 2–5 per cent of an eicosadienoic acid.

In a communication to the *Analyst* not yet available here, we have presented evidence that the C_{20} unsaturated acids of the depot fat from pigs fattened solely on skim milk largely consist of acids with less than three double bonds. This conclusion has been confirmed by examination of 4 kgm. of pig back fat. The C_{20} ester fractions consistently retained about 15 per cent of C_{18} unsaturated esters after repeated fractionation in a highly efficient column. Isomerization by treatment with caustic potash in ethylene glycol and spectroscopic examination of the resulting soaps (using the method of Mitchell *et al.* (*loc. cit.*) and the constants given by Kraybill and Beadle[8]) confirmed the presence in these fractions of an eicosadienoic acid (about 0 2 per cent of the total fat), with smaller amounts of eicosatetraenoic acid

Crystallization of 25 gm. of the C_{20} unsaturated acids yielded 10 gm. of acids, in which isomerization did not reveal more than 5·4 per cent of di- and polyethenoid acids. From the saponification equivalent (306) and the iodine value (87·9), it may be concluded that this fraction is mainly eicosenoic acid (saponification equivalent 310, iodine value 81·9).

The C_{20} unsaturated acids of pig depot fat have been thought to be derived from the diet[2,9]; but until the corresponding food fats have been examined for eicosenoic and eicosadienoic acids, the origin of these acids remains uncertain. The analyses recorded

by Hilditch and co-workers for cow milk fat[3,10] are not, however, inconsistent (as judged by saponification equivalents and iodine values of residual ester fractions) with the presence of one or both of these acids in this fat. Indeed, Bosworth and co-workers[11,12] tentatively claimed the presence of these acids in cow milk fat, a claim which seems to have been neglected by subsequent investigators

Linoleic, linolenic and arachidonic acids are known to be essential in the nutrition of rats[13,14]. The possibility of the physiological importance of eicosadienoic acid is of great interest. Work on the constitution of these acids is in progress.

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Effect of Hydrogen Ion Concentration on Cation Exchange in Clay Salts

THE lyotrope series is usually observed in the exchange of cations from clays and permutites[1,2]. Deviations from this series have also been reported[3,4]. These have been attributed to the structural peculiarities of the clays[2,3] and variations in the hydration of cations[4]. Differences in the relative effects of Ba^{++} and Ca^{++} ions in the interaction of hydrogen clays with neutral salts and bases have been observed[5,6,7], depending on the prevailing pH of the system. Symmetry values[3] of a number of clay salts against various electrolytes (chlorides) have been measured with and without adjustment of the pH of the system at a constant value by the addition of the requisite amount of hydrochloric acid. When a constant pH is not maintained, deviations from the normal lyotrope series often occur, especially in clays containing montmorillonite as judged from X-ray analysis. The deviations disappear when the symmetry values measured at a constant pH ranging from 6·0 to 7·0 are compared. At a constant pH between 3·0 and 5·0, all the cations examined give the same symmetry value, and the cation effect as envisaged in the lyotrope series altogether disappears.

At a low pH (3·0), hydrochloric acid alone gives a higher symmetry value than when used in conjunction with the salts. Al^{+++} ions are likely to be exchanged at this pH for the cations of the added salt[9]. No appreciable exchange of aluminium at this pH would occur if hydrochloric acid alone were added[10]. The lower symmetry value observed in the presence of salts can be explained if one takes into account the Al^{+++} ions exchanged for the cation of the salt.

Further work is in progress.

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A Labour-saving Method of Sampling

IF a fraction p of a population have the attribute A, then it is well known that if m members out of a sample of N have this attribute, the best estimate of p is $\frac{m}{N}$, and its standard error is $\sqrt{\frac{m(N-m)}{N^3}}$ or $p\sqrt{\frac{1-p}{m}}$. Supposing, therefore, that we want our estimate of p to be correct within a standard error of 10 per cent of its value, we must count a sample containing $100(1-p)$ members with the attribute A. If we do not know p roughly beforehand we do not know how large to take our sample. For example, if we wish to estimate the frequency of a type of blood corpuscle, and count 1,000 blood corpuscles in all, we should get such values as $20 \pm 1 \cdot 3$ per cent, or $1 \pm 0 \cdot 31$ per cent. The former value would be needlessly precise for many purposes. The latter would not differ significantly from an estimate of 2 per cent.

The standard error is almost proportional to the estimated frequency if we continue sampling until a fixed number m of the minority with attribute A have been counted, and then stop. Supposing the total number in the sample is now N, we cannot use $\frac{m}{N}$ as an estimate of p. It can, however, be shown that $\frac{m-1}{N-1}$ is an unbiased estimate of p, with standard error very approximately $\frac{1}{N}\sqrt{\frac{m(N-m)}{N-1}}$, or $p\sqrt{\frac{1-p}{m-2}}$, which is nearly proportional to p when this is small. Thus to get a standard error of about 10 per cent of the estimate we should have to count until we had observed a number m of the rarer type A, which only varies from 102 when p is very small, to 72 when it reaches 30 per cent. If we were content with a standard error of $0 \cdot 2p$ we could take a quarter of this value, and so on.

My friend, Dr. R. A. M. Case, has for some time employed a method substantially equivalent to the above in his hæmatological work, and found it to result in a considerable saving of labour.

Full details will be published elsewhere.

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Adsorption Colorimetry as an Analytical Technique

ADSORPTION of coloured substances on white adsorbents has hitherto been used either to demonstrate qualitatively the existence of the substance in a mixture or as a preliminary to elution in the quantitative assay of the substance.

In devising a simple method for the quantitative estimation of mepacrine (atabrin) in urine, a technique has been adopted which I have called 'adsorption colorimetry'. When a measured quantity of suitable white adsorbent is used, the intensity of colour produced under standard conditions is proportional to the quantity of mepacrine in the urine or in an extract of the urine. The adsorbent may easily, and with sufficient accuracy, be measured with a small scoop made by drilling a hole into a piece of wood and calibrating with a powder of known specific gravity. For mepacrine, the most satisfactory adsorbent is powdered silica gel. This may be used either directly, by adding a measured quantity to a known volume of urine for a given time, or indirectly, by adding it to an ether or chloroform extract of alkalized urine. In this way, it is possible to estimate concentrations as low as 1 mgm. per litre or less; with the common concentrations of 5 mgm. per litre or more, the error is less than 20 per cent.

This technique may obviously be extended to the estimation or detection of other coloured substances. Again, with silica gel, it has been found possible to detect bile pigments in urine in concentrations lower than those detected by the iodine or Gmelin tests; the technique is much simpler than, and the sensitivity about equal to, the Fouchet or similar adsorption methods.

Other coloured substances not adsorbed by silica gel may be adsorbed by other powders. For example, riboflavin is adsorbed by a white preparation of fuller's earth, and preliminary tests indicate that with this adsorbent an adaptation of the method of adsorption colorimetry should be capable of assaying rapidly and with reasonable accuracy and sensitivity the riboflavin content of substances of biological interest.

With fluorescent substances such as mepacrine, the sensitivity of the method may be increased one hundredfold by 'adsorption fluorimetry', that is, by viewing the adsorbent in ultra-violet light. This should make it possible to evolve a method for the estimation of mepacrine in blood, in which the concentration is much lower than that in the urine.

Details of the technique as applied to the estimation of urinary mepacrine and to the detection of bile pigments in urine will be published elsewhere.

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Structure of Stipitatic Acid

Birkinshaw, Chambers and Raistrick[1] have described stipitatic acid, a metabolite of the mould *Penicillium stipitatum*, to which, after lengthy examination, they could ascribe no reasonable structure. The evidence they give, however, does seem to indicate a unique structure for the compound. The evidence is as follows:

(1) Stipitatic acid (*A*), $C_8H_6O_5$, is a dibasic acid, solutions of the disodium salt of which are deep yellow. It contains three active hydrogen atoms and gives a deep red ferric chloride reaction. It has no ketonic or reducing properties and is optically inactive. It dissolves unchanged in concentrated hydrochloric or nitric acid, being precipitated on dilution. (*A*) itself is cream coloured.

(2) (*A*) is unchanged by bromine in acetic acid; in water it forms a loose addition compound. In 80 per cent acetic acid a monobromostipitatic acid is formed, similar to (*A*) in its properties.

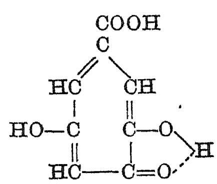
(3) (*A*) is easily converted by alkali fusion to the isomeric 5-hydroxy*iso*phthalic acid, in very good yield.

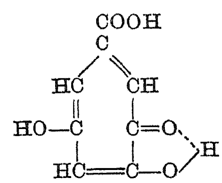
(4) With diazomethane in ether, (*A*) gives two isomeric, neutral, trimethyl derivatives. With methanolic hydrogen chloride it gives a dimethyl derivative, soluble in sodium hydroxide, but not sodium bicarbonate, solutions. With methyl sulphate and alkali it forms a dibasic monomethyl derivative the disodium salt of which is deep yellow in solution.

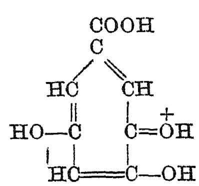
(5) With acetic anhydride and sodium acetate, (*A*) forms a monobasic diacetyl derivative; an isomeric but dibasic compound is formed with acetic anhydride and sulphuric acid.

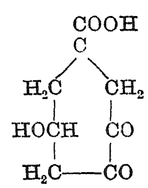
(6) Decarboxylation of (*A*) with copper in quinoline gives a monobasic acid $C_7H_6O_3$, solutions of the salts of which are deep yellow; it gives a blood-red ferric chloride reaction and with diazomethane a neutral dimethyl derivative.

(7) Catalytic reduction over platinum oxide gives a crude non-aldehydic product with half the acid equivalent of (*A*); from it tetrahydrostipitatic acid can be isolated as its dinitrophenylhydrazone.


(I)


(II)


(III)


(IV)

The stability of (*A*), particularly to bromine (2), indicates the presence of an aromatic structure; bridged ring structures are thus eliminated from steric considerations. Benzenoid or oxygen-ring structures do not explain the very facile conversion to hydroxy*iso*phthalic acid (3). There remains a seven-membered ring structure in which an α-di-

ketone group will provide the second acid function and undergo benzilic acid rearrangement on alkali fusion. When the appropriate triketo*cyclo*heptene-carboxylic acid is written in the dienol forms (I) and (II), the possibility of resonance between them by hydrogen bond chelation becomes evident; such a compound would be expected to show abnormal stability and lack of ketonic function. Moreover, the ketol group, from analogy with β-diketones, should show acidity, and the resonating ion, colour. The solubility in strong acid to a hybrid of (III) and its tautomer parallels the analogous behaviour of indophenol. The ready decarboxylation of (A) and the properties of the product are at once explained. Tetrahydrostipitatic acid (7) is probably (IV); cyclic α-diketones often give monoketonic derivatives.

The isomeric trimethyl derivatives (4) correspond to (I) and (II), in the dimethyl derivative, where the ketol and ester groups are esterified, the enolic hydroxyl is still weakly acidic. In the monomethyl derivative the lone hydroxyl is methylated (cf. the methylation of hydroxybenzoic acids).

The monobasic diacetyl derivative (5) will have the two hydroxyls protected, while the isomeric dibasic compound is presumably a nuclear acylated monoacetate; phenols are sometimes acetylated in the nucleus by acetic anhydride-sulphuric acid.

If stipitatic acid actually has the resonating structure (I) or (II), it represents a new type of aromatic system; the parent *cyclo*heptatrienolone might be termed 'tropolone'. This system would be closely analogous to azulene, while the hydrogen chelation as part of an aromatic system has long been known in the porphyrins. *Cyclo*pentadienolone may prove to have an analogous structure. An attempt to synthesize an analogue of (I) with the carboxyl replaced by methyl, by condensation of mesityl oxide with ethyl oxalate in presence of two moles of potassium ethoxide in boiling ether, unfortunately gave the isomeric benzene derivative.

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[1] *Biochem. J*, **36**, 242 (1942)

Preparation of Thin Sections of Synthetic Resins and Wood-Resin Composites, and a New Macerating Method for Wood

VARIOUS softening methods have been used in preparing sections of hard material for microscopic examination; but none of these has been found effective for so-called 'improved wood' made up of wood veneers impregnated with phenol-formaldehyde or other resin and compressed and bonded at a high temperature. The microscopic examination of synthetic resins and materials incorporating such resins is of value in revealing the nature and distribution of fillers, colouring matter and reinforcements, and other features of the internal structure. It has also been found useful as a means of identifying the different kinds of resin used as adhesives in plywood[1]. In order to prepare microscope sections of the harder forms of these materials, some investigators have had recourse to the petrologists' method of grinding and polishing thin sections for examination by transmitted light, and the metallurgists' method of examining a polished surface by reflected light.

It has now been found that a mixture of 1 part by volume of glacial acetic acid with 2 parts by volume of hydrogen peroxide (20 volumes) at 60° C. and atmospheric pressure has a softening action on fully cured phenol-formaldehyde and urea-formaldehyde resins and on wood-resin composites After being treated in this way for periods of 24–48 hours, solid blocks of resin and of various types of 'improved wood', up to ½in cube, have been sectioned without difficulty in a Reichert sledge-type wood microtome

A modification of this treatment, using equal parts by volume of glacial acetic acid and hydrogen peroxide at 60° C. for 48 hours, has the effect of decomposing or disintegrating urea-formaldehyde resin Phenol-formaldehyde resins are softened to the extent that 'improved wood' incorporating such resins is broken down and the wood itself is macerated. Incidentally, this method has certain advantages over standard methods of macerating ordinary wood for microscopic examination.

It is known that acetic acid in the presence of oxidizing agents has a delignifying action on wood[2], but this process does not appear to have been employed before in microscopic technique either for wood, resin or composite materials.

The effect of varying the proportions of the two reagents and the temperature and pressure during the reaction is being investigated further.

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[1] Rendle, B J., and Franklin G L, *J Soc Chem Ind*, **62**, 11 (1943)
[2] Wiltshire, W A, *Proc Papermkrs' Assoc G B I, Tech Sect*, **24**, 347 (1943).

Age of the Baker's Hole Coombe Rock, Northfleet, Kent

SINCE the Abbé Breuil published his view[1] that the palæolithic 'floor' at Baker's Hole, Northfleet, belongs to the Levallois I–II stage of his classification, some Pleistocene workers[2] have been inclined to follow him in correlating the superincumbent Coombe Rock with the cold phase which produced the *Rissien* solifluxion of the Somme succession.

The stratigraphical evidence at Baker's Hole is that an undisturbed 'floor' of implements rests on a bench at about 30 ft. above O.D. (which is elsewhere buried by 50-ft. Terrace deposits), and is directly succeeded by the Coombe Rock[3,4]. The precise position which we assigned to this deposit in our suggested Thames sequence[5] depended partly on the identification of the 'floor' as Lower Levalloisian. The fact that the Lower Crayford Brickearths of the 50-ft. Terrace have yielded an industry identified by Breuil[6] as Middle Levalloisian (Levallois III), together with the evidence published by Burchell[3], led us to the conclusion that the Coombe Rock antedated the Taplow-Crayford aggradation, and corresponded to the apparent coombe rock below the 50-ft. Terrace gravels exposed in the Taplow Station pit[7].

One of us (K. P. O.) has recently had occasion to handle all the material found by F. C. J. Spurrell in the part of the Northfleet 'floor' which was exposed in the Tramway Cutting west of the Ebbsfleet, and now preserved in the Geology Department, British Museum (Natural History). A number of features of this industry, including the occurrence of cordate hand-axes along with the tortoise-cores and flakes

with faceted butts, suggest that it should be compared, not with Levallois I–II of the Somme cultural sequence[8], but with Breuil's Levallois V[9]. It is particularly noteworthy in this connexion that one of the hand-axes is clearly a bifacially trimmed Levalloisian flake.

Mr. A. D. Lacaille, of the Wellcome Research Institute, informs us that on the basis of the material from the Northfleet 'floor' which he has seen in Spurrell's collection, he fully supports a revised identification of the industry. There are several possibilities[10]; but if the Northfleet industry *is* early Upper Levalloisian, rather than Lower Levalloisian, the "Baker's Hole Coombe Rock", or at any rate that part which is found in the Tramway section, must be considered as representing a later period of solifluxion than that which Breuil equates with the Riss glaciation.

Since several stages of the Levalloisian culture appear to have coincided with conditions conducive to the formation of solifluxion deposits, it is to be expected that difficulty will be experienced in dating sheets of coombe rock which happen to be associated with incompletely defined industries of the Levalloisian complex. For this reason we feel that a caveat should be entered regarding the age of the main solifluxion deposit in the Northfleet district, pending fuller elucidation of the Levalloisian complex in south Britain. We wish also to emphasize that any revised dating of the Northfleet industry does not necessarily involve so-called Northfleet types from other sites (for example, Brundon[11]) which may well be Lower Levalloisian.

The Levalloisian cores and implements collected by Spurrell[12] at the base of the Crayford Brickearths have also been seen. The evidence for their being Middle Levalloisian, rather than, say, a provincial facies of Upper Levalloisian, cannot be said to be absolutely conclusive in the present state of our knowledge of the British Levalloisian succession. Until the question of whether they are younger or older than the Northfleet industry is settled beyond all dispute, the stratigraphical implications of revised dating of the latter cannot be very usefully considered. Clearly, however, the possibility has to be borne in mind meanwhile that the Baker's Hole Coombe Rock post-dates at least part of the Crayford Series.

It is hoped that the whole matter can be gone into more fully when the sections can be re-visited and when all the collections of material from Northfleet and Crayford can be re-examined and compared.

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[1] *Geol. Mag.*, 17 (1932).
[2] Oakley, *Quartär*, **2**, 56 (1939). Paterson, *Trans Roy. Soc. Edin.*, **60**, 408 (1940–41)
[3] Smith, *Archaeologia*, **62**, 515 (1911). Burchell, *Archaeologia*, **83**, 67 (1933)
[4] Breuil, *Rev. Géog Phys. et Géol. Dyn.*, **7**, 269*ff*, Fig. 43 (1934).
[5] *Proc. Prehist. Soc.*, **2**, 61 (1936).
[6] *Geol. Mag.*, 17 (1932)
[7] Breuil, *op. cit.*, Fig 41.
[8] Breuil and Kozłowski, *L'Anthropologie*, **42**, 44, Fig. 15 (1932).
[9] *ibid*, 33, Fig. 6, No. 1, 36, Fig. 9, Nos. 2 and 4.
[10] *Trans. S.E. Union Sci. Soc.*, **48**, 31 (1943).
[11] Moir, *Proc. Prehist. Soc.*, **5**, 5 (1939).
[12] *Quart. J. Geol. Soc.*, **36**, 544 (1880). Cf. Chandler, *Proc Prehist. Soc. E. Anglia*, **2**, 240 (1916). Kennard, *Proc. Geol. Assoc.*, **55**, 139 (1944).

Distribution of Numbers and Distribution of Significant Figures

IN an earlier note[1] it is shown that the distribution of first digits of the numbers in a table will obey a logarithmic law provided that a certain sum can be replaced by an integral. We shall here discuss this approximation in more detail. The notation used will be the same as before, $f(x)$ giving the distribution of the numbers and $F(p)$ the distribution of the significant figures. We shall also introduce the distribution of the logarithms of the numbers; setting $y = \ln x$, we have for the fraction of entries with logarithms between y and $y + dy$:

$$\varphi(y)\,dy = e^{y} f(e^{y})\,dy = f(x)\,dx\,; \quad \ldots \quad (1)$$

$$\int_{-\infty}^{\infty} \varphi(y)\,dy = 1 \quad \ldots \quad (2)$$

We then have, by equation (5) of the preceding note,

$$F(p) = \frac{1}{p \ln A}\,\psi(\log_A p), \quad \ldots \quad (3)$$

where

$$\psi(q) = \sum_{m=-\infty}^{\infty} f(A^{m+q})A^{m+q} \ln A = \sum_{m=-\infty}^{\infty} \varphi(\,(m+q)\ln A)\ln A \quad \ldots \quad (4)$$

Thus $\psi(q)$ is the approximation to the integral in (2) by the trapezoidal rule; the spacing of the selected ordinates is $\ln A$, and their position is determined by q. We see that

$$\psi(q+1) = \psi(q), \quad \ldots \quad (5)$$

so that it suffices to consider values of q between zero and unity; no other values would be required for use in (3), anyhow. Also

$$\overline{\psi(q)} = \int_0^1 \psi(q)\,dq = 1, \quad \ldots \quad (6)$$

and

$$\text{if } x f(x) = \frac{1}{x} f\left(\frac{1}{x}\right), \text{ then } \psi(q) = \psi(-q). \quad \ldots \quad (7)$$

When applicable, this last relation is very helpful in determining ψ by computation.

If $\psi(q)$ were identically equal to 1, the logarithmic law would hold exactly. Functions $\varphi(y)$ for which this is true for a particular base A can readily be constructed, but it seems evident that no function can satisfy this condition for arbitrary A.

The idea that the broadness of the distribution essentially determines the closeness with which $\psi \equiv 1$ needs careful examination. If we make the distribution $f(x)$ broader by a factor α, by replacing it with the distribution $\frac{1}{\alpha} f\left(\frac{x}{\alpha}\right)$, we find that the maximum value of $|\,\psi - 1\,|$ is unchanged. The function $\psi(q)$ is simply replaced by

$$\psi_\alpha(q) = \psi(q - \log_A \alpha)\,, \quad \ldots \quad (8)$$

the sizes of the errors are unchanged, and they merely occur at different values of q.

Thus the value of $|\,\psi - 1\,|_{\max}$ is determined only by the form of the function $\frac{1}{\alpha} f\left(\frac{x}{\alpha}\right)$, and not at all by the value of the scale-factor α. Values of $|\,\psi - 1\,|_{\max.}$ for $A = 10$ for several distribution functions have been obtained by computing ψ numerically from (4) and are given below. Of these, (*b*), (*c*) and (*e*) are not inconsistent with data obtained from counting

in tables, though (b) seems not to fit quite so well as the assumption $\psi \equiv 1$ (logarithmic law)

	Function	$\lvert \psi - 1 \rvert_{max}$ $(A = 10)$
(a)	$\frac{2}{\sqrt{2\pi}a} e^{-x^2/2a^2}$	0.33
(b)	$\frac{2a}{\pi (a^2 + x^2)}$	0.0557
(c)	$\frac{4a}{\pi^2} \cdot \frac{\ln (x/a)}{x^2 - a^2}$	0.00152
(d)	$\frac{1}{a} e^{-x/a}$	0.115
(e)	$\frac{a}{(a + x)^2}$	0.0065

For $A = 100$ the values of $\lvert \psi - 1 \rvert_{max}$ become much larger, 0.24 for (e) and 0.11 for (c), thus (c) alone is not clearly inconsistent with the scanty data from counts on this basis.

Since the accuracy of the approximation $\psi \cong 1$ is not improved by increasing the scale factor α, we are led to try mixing together distributions of type $\frac{1}{\alpha} f\left(\frac{x}{\alpha}\right)$ with various values of α. If we assume that in the final mixture a fraction $\frac{1}{\beta} g\left(\frac{\alpha}{\beta}\right) d\alpha$ of the entries comes from distributions with values of α between α and $d\alpha$, then the fraction between x and $x + dx$ will be $\frac{1}{\beta} h\left(\frac{x}{\beta}\right) dx$, with

$$\frac{1}{\beta} h\left(\frac{x}{\beta}\right) = \int_0^\infty \frac{1}{\alpha} f\left(\frac{x}{\alpha}\right) \frac{1}{\beta} g\left(\frac{\alpha}{\beta}\right) d\alpha \quad . \quad . \quad . \quad (9)$$

If, in particular, $g(x) \equiv f(x)$, then we shall call h the 'iterate' of f. In our table the Cauchy function (b) is the iterate of the Gaussian (a), (c) is the iterate of (b), and (e) is the iterate of (d). It is evident from the table that iteration does rapidly decrease the value of $\lvert \psi - 1 \rvert_{max}$.

The relation (9) of iteration corresponds to the following relation between the distributions $\psi(q)$ connected with f, g, h by formulæ of the type of (4).

$$\psi^{(h)}(q) = \int_0^1 dr \cdot \psi^{(g)}(r) \psi^{(f)}(q - r). \quad . \quad . \quad (10)$$

If we represent each distribution $\psi(q)$ by a Fourier series,

$$\psi(q) = \sum_{-\infty}^{\infty} a_n e^{2\pi i n q}, \quad a_{-n} = a_n^*, \quad . \quad . \quad . \quad . \quad . \quad (11)$$

then (10) gives

$$a_n^{(h)} = a_n^{(g)} \cdot a_n^{(f)} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

In particular, iteration of a distribution function corresponds to squaring each Fourier coefficient a_n. One can show readily that since $\psi(q)$ is nowhere negative, $a_n < 1$ for all n, thus it is evident that iteration repeated a sufficient number of times will make $\lvert \psi - 1 \rvert_{max}$ arbitrarily small. If one assumes that only one harmonic exists—that is, $a_n = 0$, $n \neq n_0$—then it can easily be seen that the value of $\lvert \psi - 1 \rvert_{max}$ for the iterate is half the square of the value for the original function. This relation holds within about 2 per cent for the cases given in the table, the appearance of the computed curves of $\psi(q)$ shows that only the first harmonic is important in the cases in hand.

The fact that the close agreement between the trapezoidal sum and the integral in cases like (c) and (e) is not at all to be attributed to broadness of the distribution is seen very forcibly in the process of computing the sums numerically. In all cases considered, at least two thirds of the sum comes from the largest two terms, and at least seven eighths from the largest three. For three of the sets of ordinates computed for case (c) numerical integrations were performed by Weddle's rule, and the fractional errors found were 0·00612, 0·01224 and 0·01905—four, eight and twelve times the maximum error of the trapezoidal rule for ordinates at the given spacing.

The remarkable affinity between certain functions such as (c) and (e) and the trapezoidal rule enables us to write approximate relations of a peculiar sort. For example, from (e) we get

$$\frac{1}{\ln Z} \cong \frac{1}{4} - 2 \sum_{k=1}^{\infty} \frac{Z^k}{(1 + Z^k)^2}, \quad . \quad . \quad (13)$$

for Z real and greater than unity but not a large number. This is never exactly true, but the error becomes small very rapidly as Z is decreased. For $Z = 10$, the error is 2/3 per cent, for $Z = 4$, it is 0.004 per cent, and for $Z = 2$, it is not more than about 10^{-7} per cent and cannot be determined readily by using an ordinary ten-digit computing machine.

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[1] Nature, 154, 801 (1944).

Hissing Sounds Heard During the Flight of Fireballs

MANY responsible eye-witnesses, in their descriptions of fireballs, have emphatically stated that they have occasionally heard a peculiar hissing sound *simultaneously* with the flight of a meteor. From personal observation, I can also testify to the validity of these statements. Fireball literature is full of such accounts. Three recent cases (connected with fireballs seen by a number of competent observers at Hyderabad, on October 13, 1936, on March 25, 1944, and on August 6, 1944, respectively) have placed the matter beyond any doubt whatever.

The obvious difficulty is about the simultaneity of the light and sound phenomena noticed by observers fifty to a hundred miles distant from the meteor. But it must be remembered that the fireball rushes through the upper atmosphere with parabolic speed (about 26 miles per second); its duration of visible flight is generally 6–8 seconds. Assuming its height to be roughly 75 miles, *matter* from a *friable aerolite* can issue in a regular stream along its entire path, into the lower atmosphere, with velocity large enough to bring it in the vicinity of an observer while the meteor is still in sight. For the height assumed, four or five seconds may suffice (even allowing for air resistance) for the *matter* from the meteor to reach the air in the neighbourhood of the observer, and thus give rise to sounds variously described as like the swish of a whip, the hissing noticed while a cutler sharpens a knife on a grindstone, or a hot iron being plunged into cold water.

A shower of fine sand beating against the leaves of trees was noticed immediately after the apparition of the fireball of October 13, 1936, described in detail in *Science and Culture*, Calcutta, 2, No. 5, 273 (1936).

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RESEARCH ITEMS

Peruvian Pottery

THE gap between the Early Chimú (or Mochica) and Late Chimú pottery has long troubled students of Peruvian archæology, though Kroeber in particular has made great efforts to indicate the probable characteristics of a Middle Chimú style. Jorge C. Muelle (*Univ. California Pub. Amer. Arch. and Ethnol.*, 39, No. 3. 35 cents) despairs of finding pottery which may bridge the gap, and suggests instead that the Late Chimú pottery developed from metal prototypes, most of which have, for obvious enough reasons, disappeared. He points out many metallic features in the Late Chimú bucchero ware, and illustrates some interesting parallels between pottery and metal forms. The theory is ingenious, but it is difficult to regard it as altogether satisfactory. There are many points of similarity between Early and Late Chimú, and it seems improbable that lost metal forms can be the only link between two cultures so rich in pottery. Until the northern part of the Peruvian coast is more thoroughly explored, the possibility of finding an intermediate pottery style cannot be excluded. In support of his theory, the author makes a suggestion that the heavy stirrup-spouted "coastal Chavin" vessels were derived from metal forms, which were in their turn copied from Early Chimú stirrup spouts. In so doing he disregards the general belief that the coastal Chavin, or Cupisnique, style is earlier than Early Chimú, a belief which recent excavations by Rafael Larco Hoyle have done much to uphold.

Blood Urea Clearance of Indians

THE 'blood urea clearance' is widely used in clinical medicine as a measure of kidney function. The normal standards usually adopted are those of van Slyke for healthy Americans calculated to a standard body area of 1·7 m.². The figures are 54 c.c. for the standard clearance and 75 c.c. for the maximum clearance. C. Srikantia and D. Shamanna (*Proc. Ind Acad. Sci.*, 19, 121; 1944) have found that the corresponding average figures for healthy Indians from the Province of Mysore are 36 c.c. for the standard clearance and 47 c.c. for the maximum clearance. Grokhale (*Ind. J. Med. Res.*, 3, 627; 1941) found very similar figures for Bombay Indians. The figures suggest that the Indian kidney has only about two thirds the efficiency of its American counterpart; but whether this is true or not, it is obvious that a new and lower 'normal' standard will have to be adopted for clinical work on Indians. The first authors suggest that the lower clearance of Indians is related to the lower protein content of their diet.

Utilization of Metabolic Water in Insects

IT has often been suggested that insects developing on substances with low water-content such as flour, grain, wool, etc., obtain their necessary water from the products of food combustion. Growth in insects normally living on such dried foods is faster and higher than at low humidities. Experiments were carried out by G. Fraenkel and M. Blewett (*Bull. Entom Research*, 35; July 1944) with the flour moth *Ephestia kuehniella* and two beetles, namely, *Tribolium confusum* and *Dermestes vulpinus*. It was found that at lower humidities more food is eaten to produce a given unit of body weight, because part of the food is utilized as water. As a consequence of this, the larva grows more slowly and its final size is smaller It is shown for *Dermestes* at 30 per cent R.H. and *Ephestia* at 1 per cent R.H that less than 32·9 and 7·6 per cent of the water in the pupæ can be derived from water ingested with the food The authors consider that they have established beyond doubt that the insects in question, which normally live on very dry food, acquire a substantial, or, at extremely low humidities, the greater part of the water ultimately found in the body, from oxidation of food

Heritable Wildness in Turkeys

IN a field study conducted in the Ozark region of Missouri, A. Starker Leopold has endeavoured to assess the ingredients which make up the adaptive condition of wildness in turkeys (*Condor*, 46, 133, 1944) His method was to compare various characteristics of the native wild turkey (*Meleagris gallopovo sylvestris*), of which free populations are notably successful in the Ozarks, with characteristics of hybrid and domesticated turkeys (derived from the Mexican race, *M. g. gallopovo*) the populations of which are partially or entirely unsuccessful there Differences which appear to be directly or indirectly connected with relative wildness and domesticity are described under these heads: (1) wariness and tolerance of disturbance, (2) age of attaining sexual maturity, and the related development of secondary sex characters in males; (3) timing of the breeding cycle; (4) behaviour of hens and chicks in response to threatened danger, and the differential behaviour of chicks in the laboratory, (5) extent of moult in young birds; and (6) the relative size of the brain and endocrine glands. The original domestication of *M. g. gallopovo* was probably a gradual selective process by which the genetic constitution of the wild bird was modified to bring about a physiological adaptation to existence with man; while the wild condition of native turkeys is effectively maintained by a different set of selective factors in a natural environment

Are Genes Related to Antigenes?

A H. Sturtevant (*Proc. U.S. Nat. Acad. Sci.*, 30, 176; 1944) and Sterling Emerson (*Proc. U.S. Nat. Acad. Sci.*, 30, 179; 1944) have published a most important hypothesis of a relationship between genes and antibodies. It was suggested by Haldane in 1935 that there might be a similar molecular configuration of the antigene to that of the gene which produced it Hence the antibodies produced in reaction to the antigene might react also with the gene. The classic experiment of Guyer and Smith with the lens of the rabbit would be explained on the new hypothesis as follows: The antibodies to lens protein are free in the circulation of injected rabbits, and some combine with the genes in the germ track which are responsible for the specific lens-antigenes By so combining, the antibodies inactivate these genes, leading to the observed lens deficiency of the progeny. Thus a mutation is produced, but not in a manner analogous to a Lamarckian induction S. Emerson treated *Neurospora crassa* with antisera from rabbits treated with mycelial filtrates of this fungus. Of 270 controls from untreated cultures crossed with a standard line *N. crassa* cultures none produced a detectable mutation; among 695 cultures from treated cultures crossed with the standard line there were 25 mutations. The author suggests that the mutations were direct results of reaction between the gene and its specific antibody. The far-reaching

effects of the hypothesis necessitate further experimentation on a large scale Might it not be valuable to irradiate antibodies and to test their reactions with the originating genes ?

Virus Disease of Lupins

D. O. NORRIS (*Aust. Coun. Sci and Indus. Research Bull.* No 170) describes the symptoms of a virus disease upon several species of lupin The reactions of *L varius* are peculiar in that the first stage of infection affects the leaves, which become distorted and lighter in colour and develop necrotic areas. In the second stage, which occurs after a resting period of a fortnight or more, a large number of spindly shoots arise to give a 'bunch-top' closed appearance. The main vector is *Myzus Persicæ*, and infection may be carried over the hot dry season on *Cassia corymbosa* peas, broad beans, and sweet peas. The degree of attack on five species of lupin is inversely correlated with the alkaloid content This may be due to the unpalatability of high alkaloid plants, but *L. luteus* is low in alkaloid and is less susceptible to this mosaic disease.

Equation of State for Solids

BRADBURN'S equation of state for a solid cubic crystal of identical atoms uses the postulate that the mutual potential energy of a pair of atoms follows a law of the form $\varphi = -ar^{-m} + br^{-n}$ R. Furth (*Proc Roy. Soc.*, A, **183**, 87 ; 1944) has developed a method for determining the exponents m and n in the force law for a given element from measurements of the sublimation energy, the compressibility, the thermal expansion coefficient, and the dependence of these quantities on pressure and temperature. For many elements the predicted values of compression and thermal expansion are in satisfactory agreement with measurements up to very high pressures and to temperatures near the melting-point. The relation between melting and mechanical instability of the lattice is discussed, and a rule connecting the two phenomena is found to be closely related to Lindemann's law.

A 700-kV. D C Electrostatic Generator

A PAPER by J. F Smee (*J. Inst. Elec Eng.*, **91**, Pt. 1, No. 47, November 1944) covers in some detail the construction, development and operation of a Van de Graaff type of electrostatic generator, which was originally designed to give an output of 1 mA. at 700 kV., operating at atmospheric pressure Under certain conditions, however, this current and voltage may be considerably exceeded. Assuming that a machine can be designed *ab initio* for a given output, an allowance must be made for certain factors which cannot be precisely predicted. It appears that in all probability each generator of the Van de Graaff type which differs from others in the details of its design and construction will have its own set of special problems, which must be solved empirically for that particular machine. As the generator was originally intended for research on nuclear physics in a restricted space, the overall dimensions were reduced to a minimum. The main advantages of this type of machine in connexion with acceleration-tube apparatus of any kind are its relative cheapness of construction and maintenance, the ease with which the polarity can be reversed, and its constant current characteristic, the latter being especially valuable in its avoidance of damage to the tube or associated apparatus in the event of accidental short-circuit, failure of vacuum, etc.

Wave Mechanics in Chemistry

IN his presidential address to the Chemical Society (*J Chem Soc.*, 340 ; 1944), Dr. W. H. Mills pointed out some of the simpler aspects of wave mechanics as they may most usefully be applied to chemical problems The implications of the exchange integral and the broad theory of resonance are very clearly stated, and a detailed consideration of many actual examples shows that the ground-states of aromatic compounds may be represented as resonance hybrids in which the conventional structure is stabilized by contributions from electromeric modifications. Such matters as aromatic substitution, and the relation of five-membered heterocyclic compounds to the aromatic series, are dealt with in an interesting manner.

Titan's Atmosphere

THE March issue of *Sky and Telescope* has a brief note on Gerald P. Kuiper's discovery in January of the composition of Titan's atmosphere. The same subject is dealt with at greater length by Charles A. Federer, jun., in Science Service. It was known several decades ago that Titan had an atmosphere, but the difficulty of obtaining satisfactory spectra prevented any statement regarding its composition. Dr. Kuiper, of the McDonald Observatory of the Universities of Chicago and Texas, has photographed its spectra and has shown that it contains methane and ammonia, like Saturn. Although the gravitational pull of this satellite is only about one seventh that of the earth, and hence we should not expect it to retain an atmosphere, yet, owing to its great distance from the sun, it receives only about one per cent of the solar radiation which our moon receives. As a consequence, its temperature is very low, probably about $-160°$ C., and everything except methane must be frozen to the surface of the satellite. It is believed that clouds or droplets of ammonia are suspended in the methane atmosphere of Saturn, and probably the same is true of the atmosphere of Titan. A common origin for the satellite and its primary is indicated by the similarity of their atmospheres, in spite of the fact that the density of Titan is about five times that of Saturn. The low density of Saturn is easily explained, however, by assuming that a great portion of what we see is its atmosphere.

Orbit of Melb. 4 *AB*

W. P. HIRST has given revised elements for the two brighter components of this triple star (*Mon. Not. Roy. Astro. Soc.*, **103**, 6 ; 1943). These are compared with Voûte's elements, and it is shown that Voûte's eccentricity is too small, 0·551, as contrasted with 0·574 obtained by Hirst. Some of his other elements are also capable of improvement to a small extent. The corrections to all the elements, except the semi-axis major, were based on the angles only. Distances were not used because the earlier ones, especially those used by northern observers, occasionally show large residuals which appear, among certain observers, to be systematic. On the whole, the angle residuals are fairly satisfactory, though, as the table shows, between 1934·21 and 1934·62, there is a run of residuals of the same sign, and these (all by Voûte) have a systematic appearance. There is a long run of distance residuals from 1917·58 to 1928·53, and it is suggested that this is due mainly to low altitude or small aperture.

SIXTH-FORM PHYSICS AND CHEMISTRY

It is generally agreed that the present standard of the higher school certificate examinations, which serve as a means of selection for State and county major scholarships in addition to their function as tests of a two-year sixth-form course, strains the average candidate It is also said that they cause even the gifted boy to be cramped by a too early specialization, which reacts unfavourably on his university career and later life, a charge which is made against the open scholarship examinations at Oxford and Cambridge themselves Some of these effects are noticeable in physics and chemistry ; parts of the normal course are too exacting for the boy of moderate ability, while the boy who proceeds to the university is likely to be disappointed and unsettled by the recapitulation during his first year of work already done at school.

The report of the Institute of Physics on the Education and Training of Physicists remarked in 1943 on the economy of time and effort that could be achieved by rationalization of the whole scheme of scholarship and higher school certificate examinations. A first step towards general agreement along these lines has been made by the Cambridge Joint Advisory Committees, which have issued syllabuses* indicating the course of school work on which the Cambridge Higher School Certificate Examination, the Oxford and Cambridge Joint Board Higher Certificate Examination, and the College Scholarship examinations will be based The Science Masters' Association and the Association of Women Science Teachers were represented on the Committees, which comprised school and university teachers, and representatives were appointed as observers by the Joint Matriculation Board of the Northern Universities and the University of London Matriculation and School Examinations Council.

The syllabuses have been adjusted to the capacity of the average candidate, and designed to avoid overlapping with first-year university work. Scholarship and distinction candidates would offer an optional theoretical paper on each of the syllabuses in addition to the practical examination and two theoretical papers compulsory for all candidates, the practice which has for some years been followed by, for example, the Northern Universities Joint Matriculation Board. It is hoped that this would serve to select scholars without subjecting them to the pressure of unduly advanced work.

The Physics Committee has faced the chief problem of the sixth-form physics class—the 'weak mathematicians' and those whose interests are not primarily mathematical. It is undoubtedly possible for such boys to make good progress in physics up to a certain standard, without being able to do themselves justice in examinations with the present kind of question. They can follow a quite rigorous argument with intelligent resignation, and understand and apply the physical principles concerned, but cannot do mathematical problems of the conventional type. Most teachers will therefore approve of the list of topics, mainly mathematical, and some of acknowledged difficulty to all students (such as the force between the plates of a condenser), on which questions will not be asked.

* Cambridge Joint Advisory Committees. Syllabuses for Examinations taken by Sixth Form Pupils in Physics and Chemistry. Pp. 16 (London : Camb Univ. Press 1944.) 6d

The usual ground has been extended by including simple radio theory, and appliances such as the cinematograph, gramophone, sound film projector, loud speaker, and cathode ray oscillograph It should thus no longer be theoretically possible (as it was some years ago) for a boy to leave school, after two years of specializing in science, completely uninstructed in the principles of most of the electrical appliances to be met in the outside world

Experiments of the 'pure practical' type, involving problems on topics not necessarily covered by the theory syllabus, may be set in the practical examination The boy of outstanding promise should more readily reveal it in this kind of exercise than in the usual routine type of experiment, and a practical course containing a good proportion of these problems has a surprisingly stimulating effect on a class.

In drawing up the chemistry syllabus, the Committee concerned has borne in mind that the study of this subject should be based on experimental work, and that a clear understanding of chemical and physical principles, founded on first-hand knowledge, is of paramount importance.

In general and inorganic chemistry, importance is attached to the gradation in properties of the elements and their compounds, such as hydrides, oxides and halides ; this study to be closely linked with the Periodic Table. The Committee stresses that every effort should be made to provide the student with a mental picture of the molecular processes involved in the fusion of solids, evaporation of liquids, diffusion, gaseous reactions and chemical equilibria, and that the mathematical treatment of these topics should not be expected.

Most teachers will welcome the decision to delete from the syllabus, limiting densities, the phase rule, ionic mobilities, transport numbers and quantitative problems on solubility products, since experience has shown that these are rather beyond the grasp of the average sixth-form pupil.

In organic chemistry the usual sixth-form syllabus has been pruned considerably. Emphasis is placed on a knowledge of the arrangement of the atoms (excluding stereoisomerism) in the molecules of compounds, and of the typical reactions of characteristic groups, rather than on the preparation of a large number of compounds The economic aspects of the subject have not been overlooked, and teachers will be glad to see that the cracking of oils, polymerization of olefines, and syntheses from acetylene and carbon monoxide have been included in the syllabus.

In the practical work the Committee recommends that a knowledge of the standard qualitative analysis tables should not be required, but that analysis should be closely linked with the teaching of inorganic chemistry, and that the fundamental principles involved should be clearly understood. The identification of mixtures of salts is limited to three radicals, of which no two metals will be in the same group, and the phosphate elimination will not be required. The volumetric work is confined to acid, alkali, permanganate, thiosulphate and silver nitrate (in neutral solution) titrations, and if problems are set involving other reagents, sufficient working details will be given

The syllabuses do not seem too long for the time allowance of seven or eight forty-minute periods, which is proposed for each of the subjects, physics and chemistry ; these allowances are more generous than those on which the present arduous courses are covered in some schools

The Committees invite criticism and comment, which will be considered before further editions are issued. No doubt individual teachers will have constructive suggestions to make, and probably the very detailed list of topics for study and omission will be revised from time to time; but the syllabuses as a whole will be widely welcomed, representing as they do a standard which the majority of sixth-form boys should be able to reach.

Teachers and examiners, who have for many years accepted with patience the hitherto untested hypothesis that many of the defects of their students are due to their own excessive zeal, will have another reason for welcoming the new syllabuses. One factor responsible for literary incapacity, narrowness of outlook, and other personal shortcomings, has now been much reduced in magnitude; should these failings still persist appreciably, attention may in future be turned to other factors in the curriculum. Mere absence of intensive specialization is not enough; a sound general course for the sixth-form science student calls for the best that the humaner studies can provide, and they now have their chance.

The shifting of emphasis from the needs of the gifted few to the needs of the majority still leaves a problem to be faced. The good scholarship boy at present enters the sixth form at the age of fifteen, takes a higher school certificate examination for the first time at sixteen or seventeen, and then (in peace-time) has a year and a term at least in which to compete for awards, proceeding to the university at eighteen or nineteen. With the proposed scheme, it seems likely that boys of scholarship calibre may gain awards at seventeen, which is generally considered too young for entering a university. It would appear undesirable for these boys to spend a further year at school simply marking time with the rest of the class, and anticipation of university work is one of the disadvantages of the present system. It would be valuable indeed if the Committees, in later issues of the syllabuses, could round off an already excellent job by suggesting general syllabuses covering a year's post-higher school certificate work for those who are preparing either to enter a university or start directly on their careers after a final year at school.

AGRICULTURAL EDUCATION ASSOCIATION

JUBILEE MEETING

THE Agricultural Education Association celebrated its fiftieth birthday at a luncheon at the Holborn Restaurant, which took place during the annual conference held during December 12 and 13 in London. The principal guest was the Minister of Agriculture, who had with him Sir George Courthorpe, president of the Royal Agricultural Society, Mr. Nevill, representing the National Farmers' Union, the United States agricultural attaché, and the chairman of the Horticultural Education Association.

In his address, Mr. Hudson said that the Agricultural Education Association has important functions to perform; not the least is the opportunity it affords workers of meeting and getting to know each other. He referred to the legislation which has recently been passed providing for the establishment of a unified National Agricultural Advisory Service, and defended the decision to separate responsibility for farm institutes from the main scheme. "We want and intend to make this Service one which by its conditions, its opportunities of advancement and its scope will attract to it the most highly qualified men in all its branches", the Minister continued.

Mr. Hudson stressed the importance which he attaches to the twin jobs of education and advice for the future of agriculture. The future of the industry will depend upon the ability of the farmer to produce food at prices which will bear a reasonable comparison with the prices at which we can buy food from overseas; to do this, the industry must make use of all the latest scientific discoveries, all the most up-to-date methods that exist in the world and are suitable for British conditions. The farmer is not a person who is able to travel about freely and see and learn things for himself; it must be through the eyes and ears of technical advisers that he will be able to keep abreast of modern developments. Mr. Hudson said he is anxious about the great scarcity which exists to-day of good technical men. Men must be found for the Advisory Service: men to teach the older students at the universities and colleges; men to teach the younger students at the farm institutes: men to instruct the large numbers of ex-Servicemen; men to staff the research stations, and so on. Men with an expert agricultural training will also be wanted by commercial firms, by the Colonial Agricultural Service and in other fields. Therefore it might be difficult for a time to push on as rapidly as he would like.

Dr. Charles Crowther had previously given an account of the early days of the Association. It was founded in 1894 at the instance of Mr. Brooke-Hunt, then the one education inspector of the Board of Agriculture. At first the membership was small, consisting of a handful of heads of agricultural educational institutions and departments. Soon, membership was thrown open to members of staffs, and in 1912 the Association numbered 130. After the War of 1914–18, a great expansion took place, and the present membership is between four and five hundred. After referring to the contributions which the Association has made to experimental work, Dr. Crowther said that it has never failed to formulate its views and present them to every commission or Government committee that has reviewed the field of agricultural education during the past fifty years, and the recommendations and subsequent administrative action have shown clearly the potency of the Association's intervention. Dr. Crowther concluded with the comment that the more highly specialized agricultural education becomes the greater will be the need for the Agricultural Education Association.

A feature of the programme at this jubilee meeting were the surveys of progress during the past half-century in grassland, livestock and dairying. Very aptly, Sir George Stapledon contributed the review of grassland work. He claimed that permanent grass dominated the outlook at first. Even the pioneer investigations of Somerville, Gilchrist and Elliot were mainly directed towards permanent turf. To Gilchrist, Sir George gave the credit for bringing together the important factors of phosphates, wild white clover, sensible seeds mixtures and the greater needs of the farmer. He paid tribute to the valuable work on the nutritive value of grass carried out by Prof. T. W. Fagan and Dr. H. E. Woodman, saying that if we do not have a clear understanding of the factors influencing the nutritive value of grass we

can have no scientific basis for the proper management of grassland as feed for animals. He praised very highly the pioneer work of Hosier with his milking bails, and went on to say that a two-compartment system of agriculture, based on huge areas in permanent grass and rough grazings, and lesser areas in arable land, affords the minimum of insurance against weathering catastrophe, and makes impossible a virile and adventuring agriculture throughout the country.

Mr. James Mackintosh said that the chief change in dairying has been the increase in the demand for milk for liquid consumption. In 1875, Morton estimated that only one third of the milk produced in England and Wales was used for liquid consumption. Rew, in 1892, raised the proportion to two thirds. In 1938, of the total milk production, some 68 per cent was consumed as liquid milk, and in 1943 no less than 90 per cent was directed to the liquid milk market, and only 10 per cent was made into produce Mr. Hudson has now said that another 350 million gallons a year will be needed before rationing of milk can be discontinued. Mr. Mackintosh discussed in turn such influences on milk production as the introduction of imported foods, of improved methods of feeding, of modern methods of housing milking cows, of milk recording, and of regulations made by Government and other bodies. This was a comprehensive and very much appreciated review of progress and development.

Prof. R. G. White, dealing with British livestock during the last fifty years, believes that the most obvious advance has been in the control of disease, particularly with regard to sheep. He referred to the influence exerted by the importation of cheap phosphatic fertilizers for grassland, and of cheap feeding stuffs, on livestock, and also on the effect of changed standards of living. He commented on the fact that although Great Britain is a relatively small country, there are a large number of local breeds of sheep and cattle; while he does not see any great need for starting new breeds, he would be sorry if any of the old local breeds disappeared before we obtained much fuller information than we have at present about them and their suitability for their special environments and functions. He, too, spoke of the striking development of milk production, saying that fifty years ago about 20 per cent of our cattle were of the purely beef type, and less than 10 per cent of the purely dairy type. Now, he estimates, the figures are 25 per cent purely dairy and 15 per cent purely beef. On the subject of breeding, Prof. White said that as regards the immediate major problems of breeding policy we can still do nothing better than follow on the lines of Bakewell, nearly two hundred years ago—ruthless selection, inbreeding, followed by more ruthless selection and progeny testing. We have, however, a great advantage over Bakewell in that we understand to a great extent the effect of inbreeding. We know its value, and we realize the dangers and obstacles which are to be avoided.

A paper by Mr. E. L. Crossley described the way in which spray-dried milk powder, the demand for which in war-time has enormously increased, has been packed so as to stand up to tropical conditions for a much longer period. Specially made tins are exhausted of air after being filled with milk powder, and then supplied with nitrogen gas at a pressure of 2 lb. per sq. in. The process is simple in theory, but in practice many difficulties have to be overcome, for the vacuum employed is a low one, and the nitrogen itself must be of at least 99·7 per cent purity. This gas-packing process has extended the keeping quality of full-cream spray-dried milk to seven years in temperate climates and to at least three years in the tropics.

Mr. V. C. Fishwick submitted data from experiments with pigs to show that nutrition during the early life of the piglet has a considerable influence upon the breeding capacity and milk production of the gilt. If she is badly fed during the first twelve weeks of her life, she is liable to develop a short frame and a heavy fore end, and her capacity to produce pigs and milk is liable to be reduced. These conclusions can probably be applied to other farm stock; he suggested that the high price of milk encourages calf rearers to use little milk and unsuitable calf-rearing substitutes, so that the calves are raised on too low a plane of nutrition, with detrimental results on the animal's capacity to produce milk.

An unusual case of crop failure due to the presence of excess amounts of zinc in the soil was described by Mr. F. Knowles A field in Essex had apparently been used as a dump for the disposal of dross from a munitions factory operating during the War of 1914–18, and when ploughed up for cropping during the present War, cereals and other crops would not grow. The trouble was traced to large amounts of zinc and copper in the soil, and experiments made in pots and in the field showed that the trouble could be overcome by liming the ground. Prof. T. Wallace contributed a paper summarizing our present knowledge of mineral deficiencies in soils and crops.

Other papers were read by Mr. F. H. Garner and Dr. Dillon Weston on the growing of field beans and on the fungus diseases to which the crop is subject. There was also a useful discussion in the Biology Section on modern methods of pasture evaluation, the principal speakers being Mr. William Davies and Mr. J. Lambert, of the Grassland Improvement Station, Stratford-on-Avon. A small committee was set up to go thoroughly into the question of technique.

THE BRITISH COUNCIL

ANNUAL REPORT

THE annual report of the British Council for the year ended March 31, 1944, covers the tenth year of the Council's work and indicates not only the part the Council has played in the war effort but also its value as an instrument for the no less difficult days of peace to come. Cultural relations are not competitive but reciprocal, and no Government can look with equanimity on the prospect after the War of international competition in this field.

The British Council, with the President of the Board of Trade, initiated a Conference of Allied Ministers of Education in London, and with the Board has borne the burden of its administration, and will continue to do so until it can hand over such responsibilities to a United Nations organization. Plans for providing schools and universities with the necessary books, stationery, laboratory apparatus, radio sets and film projectors were among the subjects discussed by the Conference. Four lines of development are picked out for special mention in the report: the start of effective work in China, the increasing importance of medicine, the growing interest in British music and the services rendered to the Armed Forces

of the United States of America in Britain In connexion with the first, the report pays a well-deserved tribute to Dr. Joseph Needham, who has been working in China for the past eighteen months. Of these developments, those in regard to medicine, more particularly in contacts in this field with Turkey and the U.S.S.R. and the work in China, are the features of primary interest to scientific workers. The report notes that the Americans in Great Britain are making considerable use of the Council's facilities for professional contacts.

With regard to activities in the British Commonwealth and Empire, the appointment of Sir Harry Luke to the West Indies and of Prof. William Macmillan to West Africa has meant the beginning of serious work. Mr Malcolm Guthrie has completed the preliminary survey of East Africa. At Malta a new institute was opened in the island of Gozo by Lord Gort. In the British West Indies, the circulation of *Monthly Science News* was largely increased, and the *British Medical Bulletin* was distributed to leading medical men in the area An extensive library scheme is being sponsored for the islands with Trinidad as the centre.

A visit of British surgeons to the Soviet Union was sponsored by the British Council together with the Medical Research Council, and arrangements were made by the Medical Department of the former. American and Canadian authorities were represented. The visit gave many opportunities for the exchange of information on Soviet and British surgical methods and medical research, and the Mission was particularly impressed with the Soviet hospital organization and methods, and with the practice of early specialization in dealing with war casualties and the extremely efficient arrangements for blood transfusion. Books on many subjects have been dispatched for presentation to Soviet institutions, and further supplies of scientific material were sent to the scientific, agricultural and medical sections of the V.O.K.S. More than a thousand reprints and papers published by British scientific men during the past four years have been forwarded, and steps have been taken to centralize in the Science Museum Library, at South Kensington, London, any Russian scientific material received in Great Britain*.

By the summer of 1943, the Council was able to commence work in North Africa, and the supply and dispatch of more than 65,000 volumes of British books to libraries in Algeria, Morocco and Tunisia has been arranged. Events have made the Council almost the only means of cultural contact between Britain and Sweden, and difficulties of transport from September onwards did not prevent its work from rapidly increasing. The exchange of periodicals, mostly scientific, between Britain and Sweden is considerable, and would be much larger if transport allowed; transport also limits the contact between Britain and Sweden in the field of research. Sir Lawrence Bragg, the only lecturer from the Council to visit Sweden during the year, proved a most popular visiting lecturer and spoke on electron microscopy at four university centres and to five Anglophil societies. Dr. Dudley Cheesman gave a series of lectures on scientific development in Britain at the Wenner-Gren Institute.

The Council's work in Turkey continues to expand proportionally. The number of British professors holding chairs at the University of Istanbul, on the recommendation of the Council, is now ten, and there are three at the University of Ankara (see *Nature*, October 21, p 509) The expansion in teaching was accompanied by an extended programme of special lectures, and the Council had four distinguished visiting lecturers in Turkey during the year—Dr. B. Ifor Evans, Dr H. R. Hamley, Dr. S J Davies and Mr. J. Steegman A Turkish version, translated locally, of the *British Medical Bulletin* was published for the first time during the year, as well as a locally compiled and translated *British Engineering Bulletin*, *British Agricultural Bulletin* and *British Law Bulletin*.

In pursuance of the valuable but difficult project of translating British Standard Specifications into Turkish, B S S. No 132 (Steam Turbines) has been published in England during the present year. Six further specifications have been approved for translation and are completed and awaiting publication, and the translation of fourteen other specifications is being technically checked Three distinguished Turkish medical men, Prof. B. Tugan, Dr. Avni Aksel and Dr. B. N Taskiran, visited Britain as the Council's guests and inspected various aspects of medical organization and research.

The Anglo-Egyptian Union is so successful that membership has had to be restricted owing to the lack of accommodation. Membership of the Council's Centre in Brazil increased by fifty per cent during the year, and the distribution of *Monthly Science News* has now risen to 4,000 copies, with large numbers of new requests.

The report includes the full results of Dr. Joseph Needham's valuable scientific work in China; Mrs. Needham later joined her husband The activities of the Council's cultural scientific position in China commenced on February 24, 1943, when Dr. Needham reached Kunming (Yunnam). Within a fortnight of his arrival, it was reported that co-operation with scientific organizations and individuals had begun and that he had visited more than a dozen universities and research institutes and factories in the vicinity, lecturing on his own field and on topics of general scientific and social interest. Three weeks later he reached Chungking, and on April 3 submitted to the British Ambassador a detailed memorandum on Sino-British scientific relations and cultural co-operation, setting forth the services which might be rendered by a science co-operation officer in China, outlining the possible future developments of such an office and raising the question of technological, as distinct from cultural scientific, aid from Britain to China. Academia Sinica has now agreed to second a scientific worker to assist in matters relating to the Cultural Scientific Office, and the Ministries of Health, National Resources, Agriculture and Education are willing to co-operate. Dr. Needham left Chungking on August 7 on a round trip of 4,000 miles and has now visited more than a hundred scientific institutions in China. Since returning to Chungking he has continued the work of organizing and developing the Cultural Scientific Office. Dr. Needham's valuable and interesting articles published in *Nature* during the summer of 1943 are evidence of his activities.

Of great importance to the Chinese war effort and for the development of all branches of science in China is the supply of information and constructive ideas on the problems arising in pure and applied science. The Council's Office constitutes the link between the Chinese Ministry of Health and the

* Russian periodicals received at *Nature* office also are eventually sent to the Science Library

Medical Research Council in Great Britain, between the Chinese Ministry of Economics and Natural Resources and the Department of Scientific and Industrial Research, etc.

A fund has been set up in India for the maintenance of a Scientific Supply Service, so that the essential needs of Chinese research institutions, etc., many of which are engaged on war work, may be met. Six copies of current issues of some seventy-five British scientific journals are regularly sent to China for distribution by the Cultural Scientific Office, and it is hoped to arrange for a Chinese edition of *Monthly Science News* to be published in Chungking. *Monthly Science Abstracts and Reviews* and copies of *Endeavour* are distributed through Academia Sinica. Six positive micro-film copies of each of these seventy-five scientific journals are being sent regularly to China for distribution by the International Committee for the Supply of Scientific and Cultural Reference Materials, and this organization also handles all American supplies of micro-films. British scientific films are being supplied to the Department of Educational Cinematography of Nanking University, and a number of offprints of scientific papers from British journals have been transmitted to China at the author's wish or on request from Chinese workers. The number of text-books and monographs on scientific subjects which have reached China in response to requests passed on by the Council's Office runs into hundreds. Thirty manuscript papers in English by Chinese workers have been submitted for publication through the Chungking Office to editors of British scientific journals, and a panel of translators from Chinese to English has been assembled so that scientific papers of special interest can be translated or abstracted. A grant has been made for the preparation of abstracts in English of Chinese publications on chemical matters, and at least four hundred current Chinese scientific publications have been distributed through the Council to British scientific workers and science libraries. A science news letter, *Acta Brevia Sinensia*, giving an account of current Chinese scientific activities, is duplicated and distributed by the British Council in Great Britain. Prof. E. R. Dodds returned from China in the summer of 1943 after a successful tour of the university centres, Mr. E. Hughes has been in China since May 1942 and was remaining until the end of September 1944. Prof. W. L Renwick, who reached China more recently, has already submitted a report on the fine arts in China.

WORK OF THE ROYAL ARMY VETERINARY CORPS

MAJOR A. V. FRANKLIN, writing in the *Veterinary Record* (447, Nov 18, 1944), tells one of the most interesting and humane stories of this war. As a result of the progressive mechanization of our armed forces before the War, the Royal Army Veterinary Corps was very considerably reduced, and some prophets decided that it would never be revived. How wrong they were they will learn from Major Franklin's article. When a cavalry division was formed for service in Palestine, veterinary units of the Royal Army Veterinary Corps were organized to attend to its animals. Mobile units were also serving, at the outbreak of the War, the two cavalry regiments stationed in Palestine. Other veterinary units were attached to Indian and Cypriot mule pack transport companies operating in France. This was the extent of the British Army veterinary services until the end of 1940.

In 1941, however, a striking change occurred. The duties of the Army Remount Service were transferred to the Royal Army Veterinary Corps, which thus undertook the purchase, training and maintenance of animal reinforcements, as well as the care of the animal sick and injured. In the difficult country of Eritrea and Greece, where pack animals played such an important part, the Royal Army Veterinary Corps had ample opportunity to prove its efficiency. In Greece many veterinarians were taken prisoner and some heavy casualties were incurred. One of the saddest tasks was the rescue, by the mobile section stationed at Alexandria, in veterinary charge of the Polish Carpathian Brigade, of hundreds of mules in the North African desert. The Italians fleeing before Lord Wavell had left them there without food, water or attendance and their condition was deplorable, but they were soon restored by proper veterinary care. In Syria, several regiments of yeomanry operated with their own veterinary officers and also two mobile veterinary sections. It was here that the Royal Army Veterinary Corps showed the efficiency of its remount organization. Horses of all kinds were taken over from the Vichy French, classified, examined for disease, branded, shoed and generally conditioned before they were re-issued for service with the Allies. Here also many horses and mules were found deserted by their attendants without food or water and often in a pitiable condition. While this task was being completed, yeomanry and cavalry regiments were being mechanized and their horses were taken over and trained for transport work.

In 1942, the Royal Army Veterinary Corps was given the task of meat inspection and administration of the livestock depots from which the Army's meat supply was derived. The stock were inspected both before and after slaughtering, and this service was so beneficial that it was extended throughout the Middle East. The existing slaughter-houses were often so insanitary that the Royal Army Veterinary Corps designed and built new ones with adequate rail and road facilities. The serious danger of transmission to man of certain animal parasites which are very prevalent in bovines was removed. Later, the Corps undertook the actual selection of the beasts provided by local contractors, who soon learnt that inferior stock would not be accepted. Often, indeed, they could not supply beasts of sufficiently high quality, and the Royal Army Veterinary Corps established its own livestock depots, first in Syria and later throughout the Middle East, in which cattle, sheep, goats and pigs were reared and supplied to the Forces. Patients in the hospitals received white meat in the form of rabbits from the Corps' rabbitries. One of these depots, carrying a stock of 1,500, was able to produce 150 animals a week. The commanding officer of this depot has reported that, in Syria, parasitic disease in sheep and goats caused the deaths of one million animals in one winter alone, a loss which amounted to three million pounds sterling, or one quarter of the annual budget of the country.

In Italy, the Royal Army Veterinary Corps had perhaps its most difficult task. Many of us have heard about the mules used in this extraordinary campaign; but we have not all realized how much our men

owe to the R.A.V.C., which bought, conditioned, trained and issued these invaluable animals. This work called for high administrative and business skill. Mules had to be sought out in many countries, and the right types had to be selected and transported across land and sea. Many veterinarians were required for the pack transport companies and more for the remount depots, animal hospitals, mobile sections and laboratory services. Evacuation of animal casualties from the line and the supply of reinforcements was one of the most eagerly sought jobs in the veterinary service The Corps is now considering the extensive use of dogs.

It is certainly true that, as Major Franklin says, the story of all this work, when it can be told in full, will bring great honour to the veterinary profession. Much of the veterinarian's work, in peace-time as well as in war, is unspectacular and done with a quiet efficiency which does not get into the news It deserves the admiration and gratitude of all who care for animals. G. LAPAGE.

RELATIVITY OF TEMPERATURE RADIATION

IN his Halley Lecture[1], Prof. H. Dingle gave an outline of an entirely new application of relativity principles to thermal radiation. He has now published a more detailed account[2] which shows how far the theory has been worked out The fundamental idea is that "our theories should not imply the possibility of observing what is, in fact, unobservable". Thus in Einstein's theory of two bodies moving with uniform relative velocity, it is only this relative velocity and its limiting value which are of importance Moreover, the equality of the inertial and gravitational mass is regarded not as a remarkable coincidence, but as establishing that these two masses are two aspects of the same property.

Guided by this analogy, Prof. Dingle deals with the radiation of a black body, of constant temperature, in terms of its effect upon a second black body. He regards the equality of the emissive and absorptive powers as establishing that these are two aspects of the same property. It should have been pointed out that this equality exists only when the powers are defined in a general way[3]. The conventional definitions[4], which give absorptive power as a pure number, but emissive power as a quantity with dimensions, obscure this equality.

The most important part of Prof. Dingle's theory seems to be the analogy between the three kinematical variables, displacement, time and velocity, and three thermal variables, entropy received by a certain instrument, 'thermal time', and what I will venture to call 'radiocity', though he calls it 'radiation temperature', or simply 'temperature'. It is certainly not the usual absolute temperature, as it is approximately proportional to its fourth power. The 'thermal time' is measured by a 'thermal clock', which records what in ordinary terms would be called the total amount of radiant energy received from a black body radiating at a constant rate. In terms of these variables, Stefan's law of radiation takes the form 'radiocity is rate of change of entropy', exactly analogous to 'velocity is rate of change of displacement'. Moreover, if the zero of 'radiocity' is changed, the three thermal variables are transformed by formulæ that correspond roughly (but not in detail) with the Lorentz transformation formulæ of Einstein's theory. Finally, there is an invariant thermal interval; but this involves an expression of the fourth degree in the differentials, whereas the kinematical interval of space-time involves only one of the second order

Two applications of the theory are to the maximum efficiency of a heat engine working between fixed temperatures, and to the general equations of the thermo-electric circuit. It is difficult to find other applications, as there are few phenomena which depend only on temperature differences, do not appreciably alter the temperature, and are independent of the properties of particular substances. It is emphasized that the theory, at any rate in its present form, deals only with radiation; no claim is made that all thermal phenomena are independent of the zero of temperature.

Prof Dingle concludes by indicating how the limitation of constant temperature might be removed. As in the extension of the special theory of relativity to the general theory, it would be necessary to deal with tensors, but in the thermal case the work would be much more difficult. Perhaps some enterprising young mathematician may care to tackle this. If Prof. Dingle's arguments are sound, they open up a new line of approach to the theoretical study of radiation and a new opportunity for the use of the tensor calculus. H. T. H. PIAGGIO.

[1] *Nature*, 153 731 (1944)
[2] *Phil Mag*, 35, 499 (1944)
[3] Preston, 'Theory of Heat' (4th ed) 494.
[4] Preston, 'Theory of Heat' (4th ed), 541–42

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE annual report of the Indian Association for the Cultivation of Science for the year 1943 includes the presidential address, the report of the committee of management, including lists of papers published in the *Indian Journal of Physics*, vols. 16 and 17 and in the *Proceedings* of the Association, and appendixes on the scientific work of the Association The membership increased from 157 to 213 during the year, and of the latter figure 133 are life-members

The report on the scientific work of the Association refers to a study of primary extra reflexions in Laue photographs, in which the exact location of the absolute maximum of each extra spot at different orientations of a crystal, the spread of the intensities of the spots along different directions, the change of maximum intensity with variation in the angle of incidence, and the deviation of the direction of maximum intensity from the planes of incidence are being studied A closer study of the extra reflexions in Laue photographs of phloroglucinol crystals indicated that these reflexions are also of the secondary type and originate from the lattice degradations along the trigonal and the diagonal axes, and further investigations of this effect in benzil are in progress. Attempts are also being made to obtain accurate values of the atomic parameters in benzil crystals by a two-dimensional Fourier analysis.

Investigation of the magnetic behaviour of rare earth ions in crystals at low temperatures led to the conclusion that the paramagnetic units do not change with temperature, but the angle between the various paramagnetic units and the unit cells in these crystals

changes with the temperature Magnetic studies have confirmed the predictions as to the fine structure of potassium permanganate single crystals drawn from X-ray studies The Hall effect of molybdenite has also been investigated, and in a study of the fluorescence of anthracene crystals containing naphthacene, excited by monochromatic radiation, it has been shown that the position and number of fluorescent bands of naphthacene are independent of the wave-length of the radiation, and that the intensity of fluorescence rapidly falls to zero as the wave-length of the inciting radiation increases beyond the central part of the longest absorption band.

Research work carried out by Dr S C Sirkar covers the Raman spectra of ethyl, methyl, propyl and butyl sulphide in the solid state at the temperature of liquid oxygen. The investigation has been extended to aromatic compounds of high boiling point, such as benzyl alcohol, benzylamine and benzoyl chloride. An X-ray analysis of jute fibre has led to the grouping of the fibres into four broad classes, and the result may lead to the development of a method of classification of jute fibre similar to that adopted by the U.S. Government for cotton fibres. Mr. B. C. Guha has studied the temperature variation of anisotropy of many paramagnetic ions in crystals of salts of the iron group of metals over the temperature range 300°–80° K

FORTHCOMING EVENTS

Monday, January 15

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 8 p m.—Brigadier R. A. Bagnold "The Early Work of the Long Range Desert Group"

Tuesday, January 16

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C.1), at 1.15 p m—Dr. A. H. Seymour. "Psychological Problems of the Personnel Function in Industry".

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C 2), at 1 45 p m—Mr G. B. Gresford: "Scientific Aspects of Australia's Industrial Development"

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 p m.—Mr. Cecil Binney "Eugenics and Criminal Law".

INSTITUTION OF CIVIL ENGINEERS (RAILWAY ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W.1), at 5.30 p m—Mr. F. H. D. Page · "Railway Signalling for the Civil Engineer".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C.2), at 5 30 p m.—Discussion on "Frequency Allocation for Long Distance Communication Channels (over 1000 Miles)" (to be opened by Dr R L Smith-Rose)

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S W 7), at 6.15 p.m—Mr. P. S. Milne: "Photography and Bee-Keeping Research".

Wednesday, January 17

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1 45 p m.—Mr. Christian Barman: "Design in Modern Transport"

INSTITUTE OF FUEL (MIDLAND SECTION) (at the James Watt Memorial Institute, Birmingham), at 2.30 p m.—Mr. A. T Green · "The Properties of Refractory Materials and their Significance to Fuel Economy".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p m.—Mr. Fred Wolverson Cope: "Intraformational Contorted Rocks in the Upper Carboniferous of the Southern Pennines".

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S W.7), at 3 30 p m—Annual Meeting Dr. E. A. Cockayne: "Some Contributions of Entomology to Genetics" (Presidential Address)

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C.1), at 5.15 p m.—Mr. M G. Kendall: "The Analysis of Oscillatory Time Series".

WOMEN'S ENGINEERING SOCIETY (MANCHESTER BRANCH) (at the Engineers' Club, Albert Square, Manchester 2), at 6 30 p m.—Mr. G. E. Windeler: "Mechanical Mishaps and Industrial Accidents".

Thursday, January 18

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1). at 2.30 p m.—Prof. J Monteath Robertson: "Diffraction Methods in Modern Structural Chemistry" (Tilden Lecture).

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at the Royal Institution, 21 Albemarle Street, London, W 1), at 5 p m—Dr L A Jordan "Paint—The Art and the Science" (Jubilee Memorial Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Discussion on the Second Report on Education and Training for Engineers dealing with "Part-time Further Education at Technical Colleges, including Courses for those returning from the Services"

IRON AND STEEL INSTITUTE (joint meeting with the STAFFORDSHIRE IRON AND STEEL INSTITUTE) (at the Dudley and Staffordshire Technical College, The Broadway, Dudley), at 7 p m—Prof F C Thompson and Dr L R Stanton · "Some Observations on the Austempering and Isothermal Transformation of Steels with special reference to the Production of Martensite".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 8 p m—Symposium on "Clinical Photography"

Friday, January 19

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p.m—Mr H. J Josephs "The Fixing of Confidence Limits to Measurements"

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S W 1), at 5 30 p m—Mr Antony R. Vickers · "The Engineer and the Nation's Money"

INSTITUTE OF FUEL (SCOTTISH SECTION) (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY) (at the Royal Technical College, Glasgow), at 5 45 p m—Prof D. T A Townend "The New Era in Combustion"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned·

CIVIL ENGINEER by the Government of Ceylon, for appointment as IRRIGATION ENGINEER—The Ministry of Labour and National Service, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. E 1030 A) (January 19)

MATHEMATICAL PHYSICIST to join a small research team working on problems connected with welding—The Secretary, The University, Edmund Street, Birmingham 3 (January 20)

PRINCIPAL OF THE BARNSTAPLE SCIENCE, ART AND TECHNICAL SCHOOL—The Secretary for Education, County Education Offices Castle Street, Exeter (January 20).

ADVISER IN AGRICULTURAL ZOOLOGY—The Acting Registrar, School of Agriculture, University College of North Wales, Bangor (January 20).

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Royal Technical College, Peel Park, Salford 5, Lancs (January 22)

LECTURER IN METALLURGY—The Secretary, The University, Edmund Street, Birmingham 3 (January 30)

EDUCATIONAL PSYCHOLOGIST—The County Medical Officer, Public Health Department, Shire Hall, Nottingham (January 31).

COMMISSIONER OF PUBLIC HEALTH, Perth—The Agent-General for Western Australia, 115 Strand, London, W.C 2 (February 1).

ASSISTANT HYDROGRAPHIC SURVEYORS by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. E 904.A) (February 12).

SUPERINTENDENT OF THE HAROLD COHEN LIBRARY, and three SUB-LIBRARIANS (two in the Faculty of Arts, and one in the Faculty of Science)—The Registrar, The University, Liverpool (April 26)

ASSISTANT CHEMISTS (two) for Laboratory investigating Colonial raw materials—The Establishment Officer, Imperial Institute, South Kensington, London, S W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Proceedings of the Royal Society of Edinburgh Section A (Mathematical and Physical Sciences) Vol. 62, Part 2, No 14. On Substitutional Equations. By D E. Rutherford. Pp. 117–126. 1s 9d Vol 62, Part 2, No 15 · Quantum Mechanics of Fields, 2 · Electromagnetic Field and Electron Field in Interaction. By Prof. Max Born and Dr. H. W Peng. Pp 127–137. 2s. Section B (Biology) Vol 62, Part 1, No. 10 · Mitosis and Cell Differentiation in the Blood. By L F. La Cour Pp. 73–85+3 plates. 3s. 3d Vol 62, Part 1, No 11. Some Recent Advances in the Study of the Brain as the Implement of Mind. By Dr Richard J A Berry. Pp 86–95. 1s 6d. Vol. 62, Part 1, No. 12 · The Histochemical Demonstration of Ribonucleic Acid in Mammalian Liver. By Dr. J. N. Davidson and Dr C Waymouth. Pp. 96–98+1 plate. 1s. Vol 62, Part 1, No. 13: The Appearance in Cross-section of the Hairs of some Carnivores and Rodents. By Dr J. L. Stoves. Pp. 99–104+3 plates 2s. 3d. (Edinburgh and London Gurney and Jackson.) [2812

Re-educating Adults an Essay on Adult Religious Education. By Canon R. E. Parsons Pp 32. (London Churches' Committee for Supplementing Religious Education among Men in H M. Forces.) 1s 6d. [51

Ministry of Health Local Government in England and Wales during the Period of Reconstruction. (Cmd. 6579) Pp. 20 (London · H.M Stationery Office.) 4d. net. [51

Institution of Electrical Engineers. Education and Training for Engineers (Second Report). A Report to the Council from the Post-War Planning Committee on Part-Time Further Education at Technical Colleges including Courses for those returning from the Services. Pp. 40 (London: Institution of Electrical Engineers.) [51

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HUMAN PROBLEMS IN THE DISPERSAL OF INDUSTRY

IN the White Paper on Employment Policy, as one method of dealing with the problems of local employment and securing a balanced distribution of industry and labour, the Government proposal is to exercise a substantial measure of control over the location of new industrial development, as is contemplated in the Barlow Report The importance of such measures has been repeatedly emphasized in various connexions, particularly with reference to such regional proposals as the Greater London plan recently prepared by Sir L. P. Abercrombie. of which a limited working edition has been released to the Press and to the local authorities. Nevertheless, it is clear that so far there are no powers for giving effect to such regional plans , nor, if and when such powers are forthcoming, is the regional planning machinery adequate for the purpose. Furthermore, it is by no means certain that public opinion is yet prepared to accept the limitations on personal freedom and initiative implied in any large-scale measure of regional or national planning

It is this last point that may well prove a crucial difficulty The agitation against controls in general, and the extravagant form which the recent protest against the transfer of Civil Servants involved in the proposed location of the Ministry of National Insurance at Newcastle-on-Tyne took, are pointers to which the planners must pay full attention No blueprints or plans, on the regional, the national or the local scale, will have their full effect or be tolerated for long by the community, save in so far as they give expression and satisfaction to the hopes and needs of individual men and women, and secure the integration, and not the suppression, of the individual, with the purposes and needs of the community as a whole.

This individual and personal point of view is commonly overlooked in planning, and yet it is the one that is most vital if the plans are to be accepted and executed by the community and for the community. The report of the Social and Industrial Commission of the Church Assembly, in "The Church and the Planning of Britain", has commented on the failure of the most recent housing developments to provide adequate facilities for a natural community life, and on the social disintegration involved in enforced migration. The County of London Plan, for example, was prepared on the general assumption of the removal of about half a million people from the London County Council area, and the Greater London plan involves the resettlement of roughly a million people altogether from the County and from the first two rings—'suburban' and 'green-belt'—around it. A quarter of those, it is suggested, should go to existing towns, and nearly 400,000 to eight entirely new satellite towns, mainly in the 'outer county' ring ; a further quarter of a million should go right off the map beyond the orbit of the plan ; while 125,000 would be accounted for by existing immediate housing schemes.

Population movements of this scale are quite impossible without a parallel and co-ordinated decentralization of industry; and in the Greater London plan great care has been taken to select the new sites with full reference to their industrial suitability. The choice of brand new towns as the main reception areas for decentralization is a bold feature of the plan; but the experience of the trading estates and of the Commissioners for the Special Areas shows how difficult it is to attract both industry and workers to new rather than to existing centres. Moreover, the experience of the compulsory uprooting involved in decentralization and dispersal from London under the emergency of war does not encourage excessive optimism as to the welcome which further uprooting and dispersal would receive generally. Willing acceptance will mean the clear and painstaking explanation and demonstration of the benefits to efficiency and welfare of firms and workers which will result.

The vital importance of such educational work clearly emerges from the important study of dispersal made by the National Council of Social Service at the request of the Bank of England, which has now been published*. This inquiry was concerned with the location of clerical and administrative staffs of considerable size, whether attached to industrial organizations or not. It is not concerned with industrial location as such, but this attempt to analyse the social advantages and disadvantages of dispersal as a permanent arrangement clearly has a close bearing on the centralization or decentralization of large scientific and technical organizations such as research institutions, as well as head-office administrative staff in the usual sense. The study covers the general national interest, the interests of the organization concerned and of the reception areas as well as of those vacated, but is of special importance for the prominence given to the point of view and interests of the staff affected, hitherto largely neglected in such discussions. To this the longest two chapters of the report are devoted, for that on educational and health services is essentially a further elaboration of a subject of special importance from the point of view of the staff.

So far as war-time experience is concerned, the Committee, of which the Right Hon. Walter Elliott was chairman, is convinced that dispersal is both desirable and possible. To secure a happier social life generally, the sundering of the family by the ever-lengthening daily journeys of its units and the growing concentration of population in and around a few large cities must be arrested The war-time evacuation took place under unfavourable conditions, and many of the elements of the planning that was essential to full success were absent. It is the more important to see that the lessons to be learned are applied in preparing the basis of permanent schemes.

From the conflicting evidence, the Committee derives the impression that, of the reception areas, fairly large towns of 40,000–100,000 inhabitants, with good cultural facilities, usually gave most satisfaction. Except for a few quite small staffs, evacuation to villages or to large houses in open countryside has been unpopular It allayed unrest if at least one director or other highly placed official lived on the spot; and it helped immensely to be within easy reach of the home city, and to have facilities for occasional visits to it.

While it is now proved that dispersal is a practical possibility, given sufficient incentive, it seems clear that the majority of heads of organizations regard evacuation as a war-time expedient and intend to return as soon as the War ends. There is little doubt that the majority of the evacuated staffs, too, would vote for a return after the War to London or whichever other city they left. It is something, however, that a substantial minority of the workers should no longer yearn for the city, and this minority may be an important factor in the success of that planned dispersal which is so overwhelmingly desirable in the national interest.

The selection of the town for dispersal is only the first factor requiring consideration, and in this selection regard should be had not only to the town as it now is, but rather to its future possibilities. Closely related is the question of re-housing, and here the report suggests the formation of a housing association to avoid the objections to company houses and to municipal houses. Again, it is pointed out that there is a strong case for widening the powers of borough councils under the Housing Acts already in existence.

Scarcely less important is the question of educational provision. Here the report notes that while under the Education Act a considerable improvement in the unequal distribution of the main types of educational provision may be expected, there may be a difficult transition period during which the most prudent selection of reception towns will be necessary in order to relieve the apprehensions of many employees with regard to education—and to medical and health services also. Many towns of moderate size offer satisfactory provision to parents of moderate means; but the town needs to be selected with care, and the most important consideration at present is that the local authority should be progressive and generous. Similarly with regard to medical and health services, disadvantages compared with the great cities need not be serious so far as most of the minor ills are concerned, but the existence of a well-managed hospital, with a number of private beds at a reasonable cost, is a matter of great importance. Fairly easy access to a great city or university town where there are medical schools and special facilities is also important.

Provision for the use of leisure is of great importance also, though here it is clear there are certain misconceptions and misunderstandings to remove Facilities for indoor recreation are usually much better and much dearer in great cities than in small and medium-sized towns. For outdoor recreation the reverse is generally true. Here the report, stressing the importance of good public libraries, urges the

* Dispersal an Inquiry into the Advantages and Feasibility of the Permanent Settlement Out of London and other Great Cities of Offices and Clerical and Administrative Staffs Made by the National Council of Social Service. Pp x+96. (London, New York and Toronto: Oxford University Press, 1944) 3s 6d. net.

value of the greater opportunity for participation in communal and municipal life in the medium-sized town. This is regarded not merely as affording a way of self-expression and integration with the community; it is urged on employers that the scope provided in this way for young people to take an active part in the civic and social affairs of their neighbourhood will bring them experience which may enhance their qualifications as future managers and directors.

The relative advantages of provincial towns in this connexion, as compared with large cities, require further exploration before this argument can be used in favour of dispersal; but here, as elsewhere, the report indicates the factors which have to be taken into account and also some of the fallacies responsible for present preferences. This indeed is the main value of the report, which never suggests that the experience gained in the evacuation of the 200,000 or more employees with which it is directly concerned is all that is relevant. On the contrary, it points to other recent migrations, such as that into the Home Counties during the years 1927–39, the settlement of coal-miners in the new Kentish coalfield, the growth of new housing estates such as Becontree, and the settlement and development of Corby, which although not strictly parallel, represent experience from which, with due care, useful inferences can be drawn.

Assuming that dispersal is agreed upon as a policy, there are three phases to be distinguished: the first period of transition, possibly a year or more, when the actual transfer from the old to the new location is made; a second period, ending only when the generation of those transferred has passed; and the final settled period, when the staffs, or the overwhelming majority of them, had been recruited to serve in that locality. Only then will the considerable social stresses involved in dispersal disappear; and it is the existence of such inevitable social stress that gives enhanced importance to such questions as salaries and hours of work, and generous treatment in regard to removal expenses and housing, and prospects of promotion.

Finally, the report emphasizes the overwhelming case in the national interest for some measure of dispersal so far as London is concerned, and urges that the Government should assist by making it clear that it is in favour of such a policy and participating whole-heartedly in any general movement in respect of its own staffs. It should use its influence with large organizations to induce them to disperse. It should request local authorities to give all possible help in reception areas, and if local authorities need new powers to enable them to play their part adequately, as for example, in housing, the Government should see that the necessary legislation is introduced. Parliament may reasonably be asked to give financial assistance to local authorities to enable them to play their part.

As already indicated, it is as a stimulus to the further examination of the problems involved and for its welcome emphasis on the personnel factor that this report is most valuable. It never claims too much, but it does demonstrate that dispersal is practicable, and that it could be made a success if those concerned will give the necessary attention to the all-important details of planning, and above all to what may be best described as digging the channels of assent. Government support is essential, not the least because the full implementation of its expressed intentions as to the development of education, medical and health services and social insurance are vital factors in promoting mobility, while its powers with regard to building and other priorities could also be used constructively to give positive assistance to a dispersal policy and programme. The integration of the individual citizen affected into a new community, giving him or her full satisfaction, will never be achieved by direction from the top alone; the difficulties of personnel so lucidly outlined in the second appendix to this report must also be handled with sympathetic insight, with wisdom, courage and vigour. The support and co-operation of the staffs concerned must be secured by putting before them clearly and convincingly the national and communal reasons which make dispersal to-day imperative.

THE VAGABOND LIFE

Gypsies of Britain

An Introduction to their History. By Brian Vesey-FitzGerald. Pp. xvi+204. (London: Chapman and Hall, Ltd., 1944.) 15*s*. net.

READERS of *Nature* are probably familiar with Mr. Vesey-FitzGerald's name as a prominent naturalist and a distinguished chiropterist (he even shelters young bats inside his vest, feeding them with gentles held in his mouth). They may know further that he was for long the natural history editor, and is now editor, of *The Field*. But few know him as a writer of one brilliant story dealing with the episode of Sisera and Jael, and still fewer, until this year, knew that he is as much of a gipsy as anyone other than a pure Romany can be. Now he has given us a most interesting book on the gipsies of Britain. For the accuracy of this book I can vouch, because in the course of a medical experience of more than fifty years I, too, have studied gipsies and doctored all who came my way, in all sorts of conditions, from the heaths of West Cornwall to the open fairs of East London.

That the book is thorough no one opening its pages and looking at its table of contents could question. I have spoken of its accuracy. Its ultra-modesty is perhaps its only flaw. In his prefatory remarks, the author "acknowledges his indebtedness" to dozens of persons, not one quarter of whom could hold a candle as authorities to Mr. Vesey-FitzGerald himself. I am inclined to think that he has been rather taken in by fictitious pundits as to the nature of the Romany language, though he, himself, correctly uses and pronounces several words known to all true Romanies. I like him best when he talks really first-hand. He first read "Lavengro", that half-fictitious classic, when he was sixteen; but, he says, "I first knew a Gypsy when I was seven or thereabout. Then an itinerant harper came through the little country town where we lived. Father liked the harp and he liked characters too, and for several days the man came and played his harp outside our house. Father

talked to him and I would go out and listen, and the man would always talk to me also . . . My father was a great walker. And from the time that I was eight he would take me with him on many of his walks. . . Among the people we got to know on these walks were tramps and several families of Gypsies, who travelled the area. I had my first food in gypsy encampment when I was nine. I had my first meal alone in a Gypsy encampment when I was eleven".

People are apt to confuse real Romanies or such as carry on the true Romany tradition though not, perhaps, 'pure-bred' with all kinds of road travellers owning caravans or carts, with or without tents. Hence the bad repute into which the whole of gipsydom has fallen among the ignorant section of the public. The nearest approach to anything that can be called fraud which can be fairly attributed to gipsies are fortune-telling, and sometimes horse-coping. They are not thieves, though they may use some hazel-rods to make their tents with, or odd bits of wood lying about for their camp fires. They do not suck blood or run away with other people's children; they generally have quite enough of their own. They treat their animals well—indeed, almost as members of the family.

One of the most interesting chapters of this book is that devoted to gipsy marriages and marriage customs. The author has always found gipsy girls to be modest and chaste in their bearing, though, he says, this does not apply to their speech. Gipsies look upon marriage rather differently from ordinary conventional people in Britain. Quite often they are polygamists, as is illustrated in Borrow's writings. After all, gipsies are Oriental in origin. Mr. Vesey-FitzGerald gives an example, observed by himself, of the difference between the Oriental code and the English code. He tells us that, some years before the War, he was staying at the same hotel in France as was a very rich Oriental. "He had four wives (three of them English, and the fourth German) and they all lived together." Yet the gipsies are very keen on pre-nuptial chastity. At one time—not so very long ago—English gipsy girls used to wear a sort of girdle of chastity "made of wool mounted on catskin, from the age of twelve until the wedding day. It was fastened on by the mother every morning and removed by the mother every night, and was carried before the girl as a token of her maidenhood when she was married". According to Philip Murray, a friend of Prof. Sampson, it was then kept by the husband until it was required by the eldest daughter. Murray was an Irish tinker, who married into one of the many Gipsy Smith families. Of course, all these things have long disappeared; but a high degree of real modesty is still almost universal.

Very interesting chapters of this book are devoted to the early and the recent history of the gipsies in England and Scotland. We are told that James V signed a writ of the Privy Council of Scotland by which the gipsies were granted astonishing privileges. This writ was in effect a treaty between the King of Scotland and John Faw, a leading member of the tribe, whose name will be familiar to readers of S. R. Crockett's novels.

Interesting, also, is the chapter devoted to "Gypsy Waggons". Though not all gipsies own 'waggons', all seek their possession. The waggon is the gipsy's most valuable property. "It is home, and in it he carries his most treasured belongings—clothes, linen, china, a few photographs, perhaps medals won by himself or his family in the last war. But no true gipsy ever talks of a caravan—unless he means one of those luxurious edifices that in the piping days of peace we used to see trailing behind fast cars—he talks of a waggon or a van. And the word *vardo* really means living-waggon". In 1840, the year of publication of Dickens' "Old Curiosity Shop", we got a full description of Mrs. Jarley's waggon or caravan. That caravan is fundamentally like the caravan of to-day. The author of the present book gives a very complete and accurate picture of the typical living waggon now used. "It is a one-roomed house on rather high wheels, with windows at the back and sides and a door and detachable steps at the front. There is a rack (known as the *cratch*) at the back for carrying domestic articles of various kinds, and underneath the waggon at the back there is built a cupboard (known as the pan-box) which serves as larder and kitchen cupboard. Inside the waggon, behind the door, are a coal-stove, with a chimney projecting through the roof, a cupboard and a locker-seat. On the other side there is a corner cupboard for china, a chest of drawers in which is kept the family wardrobe and the family linen, and another locker. The whole of the back part is occupied by a two-berthed sleeping place. Naturally, just as there is some variation from waggon to waggon in external design, so all waggons are not fitted exactly in this way But the variation inside is so slight that this description may truly serve as a standard."

Not all gipsies, however, possess or desire such a luxurious home as this. I well remember when I was in practice in Cornwall, a plot of heathland on which was a sort of permanent encampment, consisting of several caravans and tents, with fires burning, and every morning proceeding from it a little slim old lady, aged eighty-two or eighty-three, walking with a good stride and bolt upright, balancing on her shoulders two long poles from which were suspended baskets, and strings of clothes-pegs—two common products of gipsy industry—marching off to the neighbouring villages to offer her goods for sale One day she confided to me that she was born under a hedge and, pray God, she hoped to die under a hedge.

But to return to Mr. Vesey-FitzGerald's book. There are chapters on gipsy medicine, fortune-telling, social organization, death and burial and other matters. It is to be hoped that this book will be widely read, and induce among hitherto prejudiced readers a little tolerance towards, and understanding of, gipsy ways and gipsy characters.

HARRY ROBERTS.

BRITISH ELECTRIC POWER STATION PRACTICE

Electric Power Stations

By T. H. Carr. Vol. 2. Second edition, revised and enlarged. Pp. xii+549. (London: Chapman and Hall, Ltd., 1944.) 32*s.* net.

In the review of the first volume of the above work (*Nature*, 153, 729; 1944), attention was directed to the importance of electric power stations, and it is evident that public interest in these is increasing, partly due to certain controversies which have arisen regarding interference with amenities, but largely because of the growing realization of the value of electricity in everyday life.

The second volume now appears in its second

edition. It describes condensing plant, feed heating, and water treatment plants, and then deals with electrical machines and equipment Supplementary chapters are devoted to plant-testing organization, station costs, fire-fighting and air raid precautions. It will at once be seen that the division of the material between Volume 1 and Volume 2 is illogical, as it would have been preferable to have had all the main steam and water components in one volume, leaving the second mainly for electrical plant.

It is doubtful if anyone inexperienced in power station practice could derive much benefit from reading this volume. Individual chapters are too elementary and inconsequential to be of value to well-informed specialists. Practically every one of them is a jumble of descriptive matter, empirical formulæ and so-called tables of data The arrangement is haphazard, and it appears that the author merely introduced tables of data at random.

Power station engineers are, however, a class apart, and many of them may find the volume acceptable because of the numerous references to troubles which have been experienced, and the descriptions of means whereby their recurrence can be prevented. A certain pleasure is also to be derived from the evident enthusiasm and energy of the author which is revealed throughout the work. His benevolent interest in the humanitarian side of management is frequently brought out in a commendable manner.

Alternators, transformers and reactors, switchgear and cables, which constitute the main components of the electrical equipment of a power station, are described tolerably clearly, and are illustrated by familiar examples from everyday British practice. Station auxiliaries, their connexions and methods of supply, have constituted a subject of controversy for many years, and a good deal of useful information is provided regarding the numerous alternatives, but the author does not come to any specific conclusion as to order of merit.

Considerable emphasis is laid on electrical protective equipment for power station plant, and the chapter dealing with this subject would serve as a useful introduction to protective gear installation and maintenance.

Another subject of first-rate importance is commissioning and testing of plant. Here again, the relevant chapter provides good introductory matter.

Power station capital and operating costs reveal in condensed and generally understandable form the economic efficiency. The short chapter on this subject gives guidance as to the best subdivision of costs, and the examples provided are of value in that certain of them are related to definite and fairly recent years, so that anyone wishing to proceed further with the analysis can relate the costs to the appropriate basic prices of materials of construction.

Most of the illustrations are good and interesting. Many of the line diagrams in both the steam and electrical sections are clear, and provide the reader with much better information than does the context. This is particularly the case in regard to Fig. 386, in which a typical metering arrangement for a power station and its interconnecting circuits is given. This diagram is clear, but the associated descriptive matter is relatively inadequate.

Each chapter has appended to it an extensive bibliography; but the author has shown no discrimination in his choice of the material included in these bibliographies, and has not even taken the trouble to arrange the items in a logical, convenient manner.

After studying this volume, the reviewer was irresistibly reminded of occasional visits to the Caledonian Market There one sees heterogeneous collections of more or less useful articles, and occasionally there is something to be found of real value. There is a place in the scheme of things for both Caledonian Markets and works of the type now considered. C W. MARSHALL.

A DICTIONARY OF PHILOSOPHY

The Dictionary of Philosophy

Edited by Dagobert D. Runes Pp. viii + 343. (London: George Routledge and Sons, Ltd., 1944.) 27*s* 6*d*. net.

THIS is a single volume, easy to handle and read, containing explanations of philosophical terms and outline accounts of schools of thought, special subjects and individual thinkers. It looks as though the efforts of a number of specialists had been put together in alphabetical order with little editing Many of the articles are just right; for example, that on 'Hegelianism', and most of the definitions of Aristotelian terms. A few articles are too brief for clarity; many are too long and try to do too much.

The article on 'Scholasticism' aims at stating the name of every writer, medieval and later, so that the subject-matter of their writing is completely lost Worst of all, it gives no references To allot six columns to Husserl's 'Phenomenology' as against three for 'Kantianism' is out of all proportion Symbolic logic spreads all over the place. So much so, that if an innocent biologist (who spends his life classifying) were to look up 'Class' and 'Class Concept', he would find something he could not understand until he read the text-book After he had read it he would discover it was no use to him. There is not even a cross-reference to 'Kind', where Mill, who has something useful to say, is referred to. Political theory comes off badly. The article on 'Political Philosophy' tries to say everything and has no references; those on 'Duty', 'Right' and 'Natural Law' are scarcely adequate, that on 'Liberty' omits the political sense; there is nothing under 'Sovereignty'; nor under the names: Dante, Marsilius, Bodin, Hooker, Burke, Paine, Malthus. Most surprising of all, in a book from the United States, there is an article on 'Aristocracy' but none on 'Democracy'. The treatment of psychology is patchy.

Very few British philosophers appear to be known across the Atlantic. Of the thinkers of the seventeenth and eighteenth centuries, Cumberland, Joseph Butler and Richard Price are absent, and Cudworth is the only Platonist to appear. At least a dozen nineteenth and twentieth century British names are absent that are up to the standard of those included. The treatment of Greek thinkers, apart from Plato and Aristotle, is meagre and conventional. Aristippus, who is little more than a myth, appears, along with a wholly mythical grandson; but not Hippocrates, who profoundly influenced Greek and all subsequent thought Euclid is there but not Aristarchus or Archimedes Indian and Chinese philosophy are dealt with; how adequately the reviewer does not know. Casual inspection seems to show that in the matter of ambiguity of terms the Chinese have little to learn from Europeans.

A really ruthless editor could turn the material in this quite useful book into a very valuable work of reference. A. D. RITCHIE.

PHOTOGRAPHY WITH THE ELECTRON MICROSCOPE

A MEETING was held on November 25 at the Royal Photographic Society's rooms in London to discuss the use of photographic materials in the electron microscope. The meeting was arranged jointly by the Scientific and Technical Group of the Royal Photographic Society and the Association for Scientific Photography.

The first speaker, Mr. G. Parr, gave a brief description of the principles of the electron microscope based upon analogy with the well-known optical microscope. Mr. L. V. Chilton, of Ilford, Ltd., followed with a paper written jointly by himself, Dr. E. M. Crooks and Dr. F. M. L. Sheffield, both of the Rothamsted Experimental Station, dealing with the behaviour of a range of photographic materials in the R.C.A. electron microscope Type B. The meeting was concluded by Dr. D. G. Drummond, of the British Cotton Industry Research Association, who showed a number of examples of the use of the electron microscope in cotton research.

Apart from early sporadic uses of photographic materials to record the variations of energies in electron beams, probably the first industrial use was in the continuously evacuated cathode ray tube. The type of tube employing a fluorescent screen is, however, much more popular, and while special problems occur, the behaviour of the photographic material is not dissimilar from its behaviour under ordinary conditions of light exposure. The photographically effective light emitted by the screen is usually blue or green, so that no abnormal problem arises in colour sensitization. A camera of the conventional type is usually used, and the only significant divergence from standard practice is the extreme shortness of exposure time which is inevitable in the photography of rapid transient phenomena. Exposure times may be as short as 0 00001 sec., and under these conditions the relative speeds of two materials may be reversed when compared with their relative speeds as measured at an exposure time of, say, 0·01 sec.

Little work seems to have been published on the behaviour of different photographic materials to the electron beam of the continuously evacuated cathode ray tube, and with the development of the electron microscope such an investigation has become more than ever necessary. A valuable contribution has been made by the authors of the joint paper read by Mr. Chilton, in which the results of tests carried out on a range of Ilford plates are described. Immediate application of the results was required for the photography of plant viruses, which give very poor contrast; and in consequence the range of materials tested was chosen for their relatively high contrast as normally measured by exposure to light.

It would be expected *a priori* that the density produced on a photographic material would depend upon the beam current and the accelerating potential. The beam current is analogous to the intensity of light and the accelerating potential to the colour. Exposures were made over a range of beam currents, and the logarithm of the value plotted against the density produced yields a characteristic curve for a given accelerating potential. By varying the accelerating voltage, a family of curves can be obtained which should show in what manner speed and contrast vary with voltage for each material. A difficulty arises which is peculiar to electron microscope technique, as the voltage is changed, the focal lengths of the 'lenses' change and this alters the current density. The correction is calculable, but the authors used a method originally due to the National Physical Laboratory in which the brightness of the image as seen on the willemite viewing screen is compared with a comparison patch of light projected adjacent to the screen through one of the viewing ports. This enables the magnification to be altered as the kilovoltage is altered to maintain equal visual activation of the screen for a constant beam current.

Several interesting features were revealed by the results. A voltage-range from 15 to 60 kv. was explored, and in all the plates tested there was a marked tendency for the contrast to rise as the kilovoltage was increased. Over the range examined the relation between kilovoltage and contrast was linear, though in some cases there was an indication that at high kilovoltages a limiting contrast was being approached, as would be expected At low kilovoltages there is a tendency for the characteristic curve to decrease in contrast at medium densities as if a relatively low maximum density was being approached. Because the contrast increases with voltage, it must not be assumed that high kilovoltages should be used for objects showing low contrast. The effective contrast of the object may itself be dependent on voltage in much the same way that an object exhibits lower contrast the higher the voltage used in the tube in radiography. The analogy cannot be pushed too far and is only given as an example. The behaviour of objects under electron bombardment may vary, so no general principles can at present be formulated, though visual observation of the willemite screen suggested in the case of plant viruses that there is a small increase of contrast with voltage. It is suggested that the decrease of contrast at lower kilovoltages is caused by the increased absorption of electrons in the outermost layer of gelatin in the photographic plate, an absorption which will be more effective the lower the energy of the electron beam. This theory suggests that the special Schumann plates in which the silver bromide crystals project through the gelatin surface (probably with a very thin covering layer of gelatin) might be worthy of trial. These plates are used for ultra-violet spectroscopy in the region where gelatin has a very high absorption.

A comparison of the relative speeds of the various photographic plates examined also yields interesting data. The exposure time given in the electron microscope was 10 sec., this figure being chosen because of the difficulty of manipulating the shutter to obtain reproducible shorter exposures. At the same time serious difficulty was experienced in maintaining constant beam current during exposures due to mains fluctuations. Both these matters might well receive attention in the design of future instruments. In addition to the electron exposures, all materials were exposed to light of various intensities for 10 sec. under normal sensitometric conditions to obtain characteristic curves to light for comparison.

At any given kilovoltage the order of relative speeds, as measured by the exposure necessary to produce a density of 1·0, 2·0 or 3·0, was roughly the same for electrons as for light, except in one instance in which the sensitivity to light was substantially augmented by colour sensitization. The total range

of sensitivities to electrons was much compressed compared with the range to light. At a density of 2·0 the total range of speeds to light was 100 to 1, whereas to the electron beam at 45 kv. it was only 13 to 1. This is not surprising when it is remembered that the photographic materials in question were made primarily for exposure to light. Quite apart from colour sensitivity, the speed of a photographic emulsion to light depends on a number of factors. In general, the larger the silver bromide grains in an emulsion the greater the speed, but even at constant grain-size a wide range of speeds can be produced by the technique employed in making the emulsion. According to modern theory, the primary action of radiation in latent image formation is the release of electrons within the silver bromide crystals. Apart from the possibility of recombination, these electrons fall into 'traps' which become charged and can then hold and neutralize the mobile silver ions, thus forming specks of metallic silver in their immediate neighbourhood. When the specks have grown to a certain minimum size the grain is rendered developable. It is believed that the initial size of the specks or electron traps is determined by the emulsion-making technique; the larger the specks, provided they are not sufficiently large to render the grain developable spontaneously, the greater the sensitivity to light. A delicate balance in all grains is not possible, so if few are to be spontaneously developable, the majority will require a significant number of added silver atoms to raise them to the necessary size It is therefore probable that the absorption of a number of light quanta is necessary to render a grain developable, and control of sensitivity can be effected over a wide range by adjustment of speck-sizes during making. When the same emulsions are exposed to X-rays or high-velocity electrons, the energy of the quanta being many thousands of times greater, it may be that the absorption of a single quantum is sufficient to provide enough electrons to enable even relatively insensitive specks to reach dimensions sufficient to render the grain developable.

This argument is necessarily only given in brief, but it suggests that sensitivity to light is much more dependent on the condition of the sensitive specks than is sensitivity to electrons or X-rays. Sensitivity to high-energy quanta would be expected to depend on the probability of a quantum being absorbed, and thus more on grain size. It is indeed possible to produce emulsions relatively very sensitive to X-rays and at the same time relatively insensitive to light, and such materials are marketed for use without fluorescent screens.

Returning to the results communicated by Mr. Chilton, he and his co-authors endeavoured to find the relation between photographic speed and kilovoltage of the electrons. This was complicated by the fact that the reference standard between the different kilovoltages was the brightness of the willemite viewing screen. Some idea of the efficiency of the screen in converting electron energy into light energy was obtained, and it was then possible to make a rough correction to the exposure axis so that direct comparison of speed at different kilovoltages was possible. This revealed that the variation with kilovoltage of speed as measured by the density produced by an arbitrary standard exposure was different for the various plates examined. In some there was little change over the range of kilovoltages used, in others the photographic speed increased with kilovoltage and reached a maximum near the upper limit of the range, and again in others there was a steady rise over the whole range.

These results show clearly the necessity for a fuller investigation, and it is to be hoped that the authors will be able to extend their work to cover a wider range of materials and conditions. Other workers have published results of a similar nature, some of which are in general agreement with the results discussed here. Substantial disagreement between results obtained by different workers is not unusual where photographic materials are concerned and should not be taken to indicate anything but the uniqueness of every photographic emulsion type. Special mention may be made of work published by von Borries (*Physikal. Z.*, 43, 190; 1942) using Agfa and Perutz plates, which shows substantial qualitative agreement in all points with the Ilford plates used in the tests described.

There is no doubt that there is much to be learned about the technique of electron micrography of different subjects, and the selection of the most suitable photographic material and its treatment. It must also be remembered that manufacturers have not yet made any attempt (or at any rate no outwardly apparent attempt) to make plates specially suited to the needs of electron microscopy. Such a development may be expected when more is known of the requirements and a demand is made for special materials, just as has occurred in the case of X-rays, and more recently in the photography of the cathode ray tube screen.

The authors of the papers who contributed to a well-attended and most successful afternoon meeting are to be congratulated on arousing interest in such an important subject, and making so valuable a contribution, which it is hoped will whet the appetite of other workers in the field who are fortunate enough to have the necessary equipment for further investigations The full text of the papers is to be published in the *Photographic Journal* early this year.

STRUCTURE OF DIAMOND

DIAMOND is generally thought to be one of the most perfect crystals occurring naturally: its atomic structure was first investigated in the very early days of X-ray crystal analysis. It turned out that the atoms of the crystal were arranged on two interpenetrating face-centred cubic lattices, the corner of one cube lying one quarter of the way along the cube diagonal of the other. Whether the resulting crystal possessed full octahedral symmetry or was of the lower tetrahedral type, a question on which crystallographers were divided, could not be settled by the additional X-ray evidence. Some ten years ago, new interest in the structure of diamond was aroused by the work of Robertson, Fox and Martin[1], who showed that the infra-red absorption and ultra-violet transparency of diamonds placed them in two classes. Of the two types, the first and commoner was opaque to both infra-red and ultra-violet radiation, while the second, Type II, is rare and is transparent to these radiations. The more recent X-ray investigations of Lonsdale and Smith[2] have shown that although the two types are structurally identical on an atomic scale, there are abnormalities in the diffraction patterns of Type I diamonds which suggest some kind of 'mosaic' structural difference in the two

types. Dr. Lonsdale's observed effects are in fact very similar to the kind of abnormality observed in the X-ray spectra of age-hardened alloys and alloys with high magnetic coercivity; they suggest a laminated structure.

There has recently appeared in India a "Symposium of Papers on the Structure and Properties of Diamond" inspired by an idea due to Sir C. V. Raman[3]. The symposium runs to more than 150 pages and contains seventeen papers by Raman and his colleagues. The fundamental idea, contributed by Raman, is that there are four structurally possible arrangements of carbon atoms which are all in agreement with X-ray data. Two of these, which, following Raman, we may label *Td* I and *Td* II, will give a crystal with tetrahedral symmetry, and two, *Oh* I and *Oh* II, will produce the full octahedral symmetry. The two tetrahedral types are physically identical but geometrically different: the octahedral types are physically distinct and might have slightly different lattice parameters.

Raman then supposes that something in the nature of twinning or parallel growth of these different but closely allied types occurs. Twinning of the two *Td* types would be difficult to detect as it would produce little, if any, internal strain on the crystal. But union of a *Td* with either of the *Oh* types might be detectable as a result of strains due to slightly different lattice spacings. Twins of the two *Oh* types might also produce observable strains. Raman thus suggests that there are more than the two types recognized by Robertson, Fox and Martin, and that some diamonds may be 'mixtures' of the different types. The position can perhaps be best summarized in tabular form; the lower part of the table is derived from material taken from the Indian symposium.

<table>
<tr><td colspan="2">Type I
Numerous
Infra-red absorption
Opaque to ultra-violet
Blue luminescent
Abnormal X-ray spectra</td><td colspan="2">Type II
Rare
Transparent to infra-red
Transparent to ultra-violet.
Not luminescent
Normal X-ray spectra</td></tr>
<tr><td>Tetrahedral
Td I or *Td* II,
physically identical</td><td colspan="2">Mixed
Twins of *Td* and *Oh*</td><td>Octahedral
Oh I and *Oh* II,
physically distinct</td></tr>
<tr><td>*Birefringence Patterns*
Non-isotropic (but anisotropic according to R F and M)</td><td colspan="2">Related to structure</td><td>Related to structure (but isotropic according to R F and M)</td></tr>
<tr><td>*Luminescence Pattern*
Uniform blue luminescence</td><td colspan="2">Blue and yellow pattern of lines and dark patches.</td><td></td></tr>
<tr><td>*X-ray Topography*
Uniform intensity of reflexion.</td><td colspan="2">Mixture of uniform regions with streaks related to structure.</td><td>Parallel strips of low intensity</td></tr>
<tr><td>*Ultra-violet Transparency Patterns*
Opaque with faint blue luminescence or partially transparent with strong blue luminescence</td><td colspan="2">Patches of opaque and transparent regions; related to structure</td><td>Transparent</td></tr>
<tr><td>*X-ray Reflexion*
Intensity increases with blue fluorescence</td><td colspan="2"></td><td>Great intensity indicates small-scale mosaic structure</td></tr>
<tr><td>*Photoconductivity.*
Small.</td><td colspan="2">Moderate</td><td>Large.</td></tr>
</table>

The evidence in support of Raman's theory is really supplied by those experiments which indicate that a particular diamond is not homogeneous. These are the experiments on birefringence (where the results are at variance with the observations of Robertson, Fox and Martin), luminescence and ultra-violet transparency patterns. The item in the table "X-ray Topography" deserves some fuller explanation; under this title G. N. Ramachandran describes an ingenious method of obtaining an X-ray image of a crystal flake in which variations of reflecting power are recorded. Such variations appear to be related to the ultra-violet transparency and other properties of the diamonds.

The symposium is not wholly devoted to a demonstration that four different types of diamond do exist. There are several papers dealing with the properties without reference to the particular type. R. S. Krishnan contributes a paper on the Raman spectrum of diamond, based on Raman's interpretation of the dynamics of the crystal lattice, while B. Dayal applies the same ideas to the evaluation of the specific heat of diamond. An examination of the magnetic susceptibility by A. Sigamony shows that this property is not structure sensitive and that it does not change when a fluorescent diamond is irradiated with an intense beam of light.

The symposium concludes with an interesting paper by S. Ramaseshan describing the external form and surface markings of twenty-nine diamonds from Panna in their natural state. Considering the perfection usually ascribed to diamonds, the marked curvature of the faces of natural crystals is not without interest.

The authors who have contributed to the symposium have been fortunate in having at their disposal a collection of 310 diamonds made by Sir C. V. Raman. This wealth of material has been an undoubted help to them, and contributes effectively to the value of the work they have carried out. There is evidently an interesting problem here, not yet completely solved; one key to it lies in a more complete understanding of the abnormal X-ray reflexions recorded by Lonsdale and Smith. G. D. PRESTON.

[1] Robertson, Fox and Martin, *Phil. Trans. Roy. Soc.*, A, **232**, 463 (1934); *Proc. Roy. Soc.*, A, **157**, 579 (1936).
[2] Lonsdale and Smith, *Nature*, **148**, 112 (1941).
[3] Raman and others, *Proc. Indian Acad. Sci.*, *Bangalore*, 189-342 (1944).

SOIL CONSERVATION IN THE ANGLO-EGYPTIAN SUDAN

By E. N. CORBYN

Formerly Governor of Khartoum

IN December 1942, a committee was appointed by the Governor-General of the Anglo-Egyptian Sudan to consider the problem of soil conservation in the Sudan; it was constituted as follows: Dr. J. D. Tothill, director of agriculture and forests; Lieut.-Colonel C. P. Fisher, director of the veterinary service; Mr. J. Smith, chief conservator of forests; Mr. G. Andrew, Government geologist; and Messrs. G. M. Hancock and B. Kennedy-Cooke, Sudan Political Service. The Committee's report has just been issued*.

The terms of reference of the Committee were: (*a*) To report on the present situation in the Sudan with regard to soil erosion and desiccation and the

* The Report of the Soil Conservation Committee, Sudan Government, 1944. Pp. 161+12+2 maps. (Khartoum: McCorquodale and Co. (Sudan), Ltd.; obtainable from Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1.) 2*s.* 6*d.* net.

availability of rural water supplies for the human and animal population. (b) To make recommendations in respect of any of the above matters and of any measures of legislation or taxation which may be required for the carrying out of such recommendations. (c) To draw up a programme of work covering a stated period of years for the implementation of the recommendations. (d) To provide estimates of the capital cost of carrying out the programme and of the future maintenance costs involved

The findings of the Committee are securely based on the best expert scientific knowledge available to the Government, and the standard of the Sudan in such matters is high. This powerful effort to lay down the broad lines on which, over a territory of a million square miles out of the eleven and a half millions which constitute Africa, the three-fold dangers of soil erosion, devegetation and desiccation shall be met, deserves the flattery of imitation by every governmental authority in that continent. How widespread is the desire of African Governments to deal with these menaces adequately was shown by the success of the International Commission set up in London to study them in 1942 by the Royal African Society, under the chairmanship of Prof. E. P. Stebbing, in which the cordial co-operation was obtained of the French and Belgian African administrations, and to which the Dutch Government contributed the fruits of its Asiatic experience.

The Sudan is particularly well placed to state whether there is a 'desert creep' of the Sahara southwards in its area, as it borders upon the south-eastern portion of the great Libyan Desert. The findings of the Committee are on the whole reassuring on this point; but this may be due in this region to something of a piece of geological good fortune, namely, the deposit, from the Sahara southwards to about lat. 10° 30′ N., of a great 'blanket' of sand, dating from glacial times, which "has been static or fixed for several thousands of years . . . and is everywhere anchored or fixed by vegetation grading from light forest to heskanit [a tough grass] depending on local rainfall. . . . Being permeable in structure and fixed in position it prevents erosion from taking place". This sand forms, fortunately, a cultivable soil.

The clay plains south of this great area of 'continental' sand, and the clay plains of the major portion of the country in general, do not share the comparative immunity of the sand area from erosion, and their problem is similar to that of other parts of Africa.

The Committee does not consider that there has been any great alteration of climate in the direction of desiccation within historic times—say, the last 5,000 years. But it finds abundant evidence of alternations of both wet and dry periods in previous geological times. It concludes, therefore, that such desiccation and erosion as have taken place, and are taking place, are due to the activities of human beings and their animals, and can consequently be controlled by bringing about changes in these activities sufficient to restore damage and prevent further deterioration.

The Committee's survey of existing conditions in the Sudan showed many and serious examples of soil deterioration as at present taking place. Sheet erosion was found to be occurring in many places in the hill country of southern Kordofan and of Equatoria, and near the gullied land of the Blue Nile. Gully erosion was noted as common and locally important in Equatoria, along the banks of the Blue Nile, Dinder and Atbara Rivers, in the hills of Kordofan, and in the coastal range of Red Sea hills. Soil deterioration due to overgrazing, and over-cropping was found to be common in all the thickly populated areas.

Deterioration of forest watersheds due to fires and grazing was observed as taking place in the Red Sea hills, in the hills of southern Kordofan and of the southern Fung and eastern Upper Nile districts, and in the hills and mountains of Equatoria, where it is sometimes also due to agricultural development of the heads of valleys.

Spoliation of agricultural land by silt dune formation was found to be taking place in the delta of the Khor (River) Baraka around Tokar. Spoliation of rain-watered agricultural land by out-of-season fires was noted as common on the clay plains of Kassala, Blue Nile, Upper Nile and Kordofan.

Finally, town and village peripheries were found to be deteriorating rapidly all over the country, owing to over-cultivation and over-grazing of the surrounding areas, and excessive cutting of trees for firewood in the neighbourhood of towns.

An extensive programme of more than fifty items, covering different danger-points spread over all the eight provinces of the Sudan, is put forward by the Committee, to some thirty of which a priority classification is given as matters of urgency.

The remedies recommended fall under main headings as follows:

(1) Methods of rain and flood-water control: gully plugging; contour terracing; protection of heads of catchment areas.

(2) Forest protection: reservation of forest areas to an increased extent; protection from fire; re-afforestation; control of fire-wood supplies.

(3) Treatment of cultivable rain-watered grasslands: control of annual burning methods; fire protection.

(4) Control of town perimeters, including reservation of areas for the growing and supply of fodder for domestic animals, and for fire-wood, whether from near or distant sources; control of village planning, so far as necessary to ensure conservation and the best use of the soil of village areas; control of the grazing habits of nomads, so far as necessary to avoid deterioration in the soil of grazing areas.

Two great merits of the report are that its recommendations apply these remedies to definite schemes at definite places, and that financial estimates of the cost of these schemes on a basis of a five-year experimental period are worked out and provided, totalling in the first instance to a sum of £300,000, spread over five years, to be at the disposal of a board appointed for the purpose.

A considerable part of the Committee's recommendations falls under the heading of improvement of water supplies, a most important matter in so arid a country, and one which in itself will relieve the strain on soil surrounding the water-points which exist already in agricultural and grazing areas.

The Sudan Government has accepted the main recommendations of the Committee, and will make the necessary funds available for the five-year trial period envisaged. It has appointed a Water Supplies and Soil Conservation Board to administer the funds provided and to take executive action on the schemes proposed.

NEWS and VIEWS

Prof. Eric Ashby: Australian Scientific Attaché to the U.S.S.R.

PROF. ERIC ASHBY, professor of botany in the University of Sydney, has been appointed scientific attaché, with rank of counsellor, to the Australian Legation in Moscow, for about a year. Prof. Ashby's appointment has been made in order to establish contact with leaders of science in the U.S.S.R., and particularly with those working on problems of mutual interest to that country and Australia. Since Prof. Ashby's appointment to the chair at Sydney in 1938, he has established himself in Australia as a first-class man of science and organizer. He was chairman of the Australian National Research Council during 1940–42 and is honorary scientific adviser to the Australian Department of War Organization and to the Scientific Liaison Bureau. He is well acquainted with the scientific resources of Australia, for in 1942 he carried out a survey of them for the Prime Minister. In his own botanical researches he has made a special study of crop development. Therefore it is clear that the Australian Government has made a very wise choice for its first scientific attaché to the U.S.S.R. Prof. Ashby is now staying in Britain for a short time, before proceeding to Moscow. It is possible to get in touch with him by communicating with the Editors of *Nature*.

Tropical Medicine at Liverpool

LIEUT.-COLONEL B. G. MAEGRAITH, who is at present in charge of the Army Malaria Research Unit, has succeeded, at the age of thirty-seven, the late Prof. Warrington Yorke in the Alfred Jones chair of tropical medicine at the Liverpool School of Tropical Medicine. After graduating at the University of Adelaide in 1930, Prof. Maegraith went to Oxford as a Rhodes Scholar and there took his B.Sc., D.Phil. and M.A. He was awarded a Beit Fellowship and became fellow of Exeter College and tutor in physiology. Later, he acted as dean of the Oxford University Medical School. Earlier in the War he served as consulting physician and assistant director of pathology in the West African Command and there studied, with Brigadier G. M. Findlay and N. H. Martin, the factors present in tissues and blood which may produce or inhibit lysis of the blood cells. In Australia, Prof. Maegraith had made a hæmatological study of the aborigines, and later he studied hæmolysis.

Physical Anthropology at Oxford

DR. J. S. WEINER has been appointed to the readership in physical anthropology at the University of Oxford. Before the War he was engaged in a study of the physiological characteristics of the Bantu people, with special reference to heat tolerance and vitamin C nutrition. More recently he has been concerned with war-time problems of acclimatization. Dr. Weiner's appointment marks a new orientation in the development of physical anthropology in Great Britain. While in the past the subject has been mainly confined to the statistical study of purely morphological variations in skeletal dimensions, its future development is likely to be concerned with such practical problems as racial variations in physiological efficiency.

Harrison Memorial Prize for 1944

THE Selection Committee, consisting of the presidents of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, has awarded the Harrison Memorial Prize for 1944 to Dr. Leslie F. Wiggins, of the University of Birmingham, in recognition of his researches on transformation products of the hexose sugars. His originality and resource, combined with exceptional experimental skill in these investigations, have opened new fields of theoretical interest. Much of this work holds promise of practical development along novel lines.

U.S. National Academy of Sciences

Elections

THE following elections to the U.S. National Academy of Sciences were made at the 1944 Annual Meeting:

Members: Prof. Thomas Addis, professor of medicine, Stanford University Medical School, San Francisco, California; Dr. Charles Armstrong, surgeon in the United States National Institute of Health, Bethesda, Maryland; Prof. Philip Bard, professor of medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland; Prof. G. W. Beadle, professor of biology, Stanford University, California; Prof. Hans A. Bethe, professor of physics, Cornell University, Ithaca, New York; Prof. Edward U. Condon, Westinghouse Research Laboratory, East Pittsburgh, Pennsylvania; Dr. George O. Curme, jun., Carbide and Carbon Chemical Corporation, New York, N.Y.; Dr. Hugh L. Dryden, National Bureau of Standards, Washington, D.C.; Dr. Carl O. Dunbar, Yale University, New Haven, Connecticut; Prof. Vincent du Vigneaud, professor of biochemistry, Cornell University Medical College, New York, N.Y.; Prof. James Franck, professor of physics, University of Chicago, Chicago, Illinois; Prof. Reynold C. Fuson, professor of chemistry, University of Illinois, Urbana, Illinois; Prof. Edwin Bret Hart, professor of agricultural chemistry, University of Wisconsin, Madison, Wisconsin; Prof. Selig Hecht, professor of zoology, Columbia University, New York, N.Y.; Mr. Alfred H. Joy, Mt. Wilson Observatory, Pasadena, California; Prof. Esper Signius Larsen, jun., professor of petrology, Harvard University, Cambridge, Massachusetts; the Rev. James B. Macelwane, *S.J.*, director of the Institute of Geophysics, St. Louis University, St. Louis, Missouri; Prof. Leonard A. Maynard, professor of animal nutrition, Cornell University, Ithaca, New York; Prof. Barbara McClintock, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, Long Island, New York; Prof. C. R. Moore, professor of zoology, University of Chicago, Chicago, Illinois; Prof. Alfred S. Romer, professor of zoology and curator of vertebrate palæontology, Harvard University, Cambridge, Massachusetts; Prof. Louis B. Slichter, professor of geophysics, Massachusetts Institute of Technology, Cambridge, Massachusetts; Prof. Lee I. Smith, professor of organic chemistry, University of Minnesota, Minneapolis, Minnesota; Prof. Don M. Yost, professor of inorganic chemistry, California Institute of Technology, Pasadena, California; Prof. Oscar Zariski, professor of mathematics, Johns Hopkins University, Baltimore, Maryland.

Foreign Associates: Sir Edward Bailey, director of the Geological Survey of Great Britain; Prof.

Leopold Ruzicka, Department of Organic Chemistry, Institute of Technology, Zurich.

Presentation of Medal and other Awards

At the same meeting, the following medal and other awards were presented:

Daniel Giraud Elliot Gold Medal and Certificate (awarded annually to the author of an outstanding paper, essay or other work on some branch of zoology or palæontology), to Prof. Malcolm R. Irwin of the University of Wisconsin, for his work "Immunogenetic Studies of Species Relationships in Columbidae" (*J. Gen.*) (for 1938); Prof. John H. Northrop, Rockefeller Institute for Medical Research, Princeton, New Jersey, for his work "Crystalline Enzymes: the Chemistry of Pepsin, Trypsin and Bacteriophage" (Jessup Lectures, Columbia University Press) (for 1939); Prof. William B. Scott of Princeton University, for his work "The Mammalian Fauna of the White River Oligocene. Part IV Artiodactyla" (*Trans. Amer. Phil. Soc.*) (for 1940).

Mary Clark Thompson Gold Medal (awarded annually for the most important services during the period in geology and palæontology), to Prof. Edward W Berry of Johns Hopkins University, for outstanding contributions to knowledge of the Mesozoic and Cenozoic floras of North, Central and South America, and the Antilles, in their relations to stratigraphy, the ecology and geographic distribution of past floras, and the evolution of the different groups of flowering plants (for 1942); Dr. George G. Simpson of the American Museum of Natural History, for his outstanding contributions in the field of vertebrate palæontology, including a study of the Mesozoic mammals, and distinction as a field collector, systematic palæontologist and original thinker on broad problems of evolution (for 1943); Dr. William J. Arkell, formerly of New College, Oxford, now with the Ministry of Transport, for his outstanding contributions to palæontology and geology, including intensive studies of stratigraphic units of different geologic age in widely separate regions, British Jurassic faunas, the history of the region of Great Britain in Jurassic times, palæoecology, the late Neogene history of the Nile region, and other services, all leading to important publications.

Ordnance Distinguished Service Award of the Ordnance Department, United States Army. This was presented to the National Academy of Sciences "in recognition of outstanding and meritorious scientific services, in war and peace, for the development, manufacture and maintenance of Ordnance material". The award was authorized on July 20, 1944, and was presented by Major-General G. M. Barnes, chief of the Research and Development Service, Ordnance Department.

Textile Industries at the University of Leeds

THE steady expansion of the wool textile industry of Great Britain up to 1914 was based on the lead given by early textile inventors, aided by the unique skill acquired by successive generations of craftsmen. A great structure had been erected on a foundation of simple empiricism; but the industrialist was still applying imperfectly understood processes to a material of unknown composition and properties. As the training of textile technologists was in the hands of craftsmen with neither scientific training nor research experience, there could be no hope of breaking the vicious circle of empiricism until scientific workers were persuaded to make a study of textile materials and processes. A first step in this direction was taken by the Department of Textile Industries of the University of Leeds in 1919, when a lecturer in textile chemistry was appointed. From this small beginning it was hoped in time to build up such a body of knowledge that textile technology would be transformed into an applied science. This, in turn, was intended to provide the Department with a staff of technologists having scientific as well as technical qualifications; to create a bond between science and the industry by giving its recruits a combined training in science and technology; and to provide industrial research laboratories with scientific men trained in the methods of research on textile materials and processes.

All these aims have now been achieved, owing to the rapid expansion of the research section of the Department since 1928, when the Worshipful Company of Clothworkers made a grant of £3,000 a year for research purposes. The grant made it possible to appoint a lecturer (now reader) in textile physics (Dr. W. T. Astbury) and two research assistants, besides providing a number of scholarships and fellowships for research workers drawn from the science departments of the universities. Dr. Astbury's work has since been supported by the Rockefeller Trustees, and that of the Textile Chemistry Section by a number of organizations and firms. Both the Textile Physics and Textile Chemistry Sections have been responsible for important advances in pure and applied science, and, excluding staff, there are now twenty-seven research workers in the Department. Its interests cover the whole field of high polymers, from cellulose and the proteins to plastics and synthetic fibres, from biology to technology. A craft has been carried to the forefront of the applied sciences in a single generation.

Needless to say, such rapid expansion has brought difficulties in its train. In a Department which was originally non-scientific, the difficulty of providing accommodation for research workers was always acute, and is now intensified by the needs of the technological staff. Every spare room has been converted into a laboratory, an army hut has been brought into service, and temporary accommodation has been provided in one of the laboratories of the sister Department of Colour Chemistry and Dyeing. The time has now come to consolidate the position, to collect together scattered groups of research workers and to provide research facilities for the technological staff. Two schemes of reorganization are proposed at a total cost of £22,000, towards which Messrs. Imperial Chemical Industries, Ltd., Dyestuffs Division, and the Tootal Broadhurst Lee Co., Ltd., have each made donations of £2,500.

The International Setting of Reconstruction

UNDER the general title "Looking Forward", the Royal Institute of International Affairs is publishing a series of pamphlets on the international aspects of reconstruction, which are intended to stimulate thought and discussion, and to aim at presenting problems rather than to solve them. In the first of these, "Britain and the World" (Pp. 60. 1*s*. net), the Hon. H. A. Wyndham gives an outline of reconstruction problems; the general background in Europe and the Middle East, and such factors as freedom of trade and migration in the nineteenth century and up to 1939 are discussed in the first part, and Britain's position in the post-war world is considered in the

second part. Some home problems, such as industry and its organization and control, demobilization, exports, social insurance, housing and agriculture, health and educational services are briefly indicated in the third. The second chapter indicates some of the implications of the Atlantic Charter in such matters as relief and rehabilitation in Europe and the Middle East, the significance of the Hot Springs Conference, the potentialities of the Middle East Supply Centre, the problem of Germany and the special problems of the British Empire, such as the co-ordination of foreign policy and defence and trends in colonial welfare and development. Although necessarily sketchy, the pamphlet succeeds in indicating the relation of particular problems to the larger issues, and the problems of home and international policy, on the solution of which Britain's economic stability, social security and future prosperity depend.

Typhus in Guatemala

THE July issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an account of an outbreak of typhus by Dr. Julio Roberto Herrera, head of the Section of Epidemiology of the General Health Office of Guatemala. He stated that he received on April 3, 1944, a notification of 198 cases of an infectious disease, which turned out to be typhus, in a home for the insane, a general hospital and a penitentiary. There were altogether 198 cases with 63 deaths. The case fatality for the home for the insane was 26·10 per cent. Preventive measures included quarantine of the foci, restriction of visits, disinfection and disinsectization of the hospitals, barracks, etc , verification of definite and suspected cases by public health laboratories, visiting of all contacts, immunization of exposed staff, examination of autopsy specimens, organization of a national disinfection station, education of the public by the Press, radio, etc., isolation of cases and supervision of hospitals and welfare stations.

British Dragonfly Records

MISS CYNTHIA LONGFIELD, British Museum (Nat. Hist.), Cromwell Road, London, S.W.7, writes: "As I shall be revising for publication, in the very near future, the records on distribution of all the British dragonflies, I shall be most grateful if all collectors, who have not done so already, will send me their lists of localities, including approximate status, of dragonflies identified up to the end of 1944. Observations on habitats, definite proof of breeding and methods of oviposition will be most valuable. All help will be gratefully acknowledged."

Royal Institution: Graduate Memberships

THE first three of the graduate memberships recently established by the Managers of the Royal Institution for recent graduates, of either sex, of any university in the British Empire who have obtained first- or second-class honours in any scientific subject, have just been awarded. The recipients are: Miss June M. Broomhead, who gained a major scholarship in 1941 and a research scholarship in 1944 at Newnham College, Cambridge, and was placed in Class II (1) in the Natural Sciences Tripos in physics, 1944; Mr. Robert B. Morrison, who took first-class honours in physics in the University of London, 1944, and is now University demonstrator at King's College; and Mr. Anthony P. Waterson, who took a first class in Part I of the Natural Sciences Tripos, Cambridge, 1943, and in Part II (biochemistry), in 1944. He is studying medicine at the London Hospital.

Royal Aeronautical Society: British Empire Lecture

THE Council of the Royal Aeronautical Society has recently completed arrangements for the founding of a British Empire Lecture. The Lecture, on any aeronautical subject approved by the Council, will be delivered annually in September in London, by a lecturer chosen in alternate years from the British Dominions and Colonies and Great Britain. The Society, by founding the Lecture, is anxious to encourage new ideas and new points of view from all parts of the British Empire, and to make the lecture second in importance only to the Wilbur Wright Memorial Lecture. The British Empire Lecture will have a premium of £50 attached to it, and in the case of lecturers coming from the Dominions and Colonies an allowance up to £100 will be paid towards the lecturer's expenses. It is proposed to hold the first lecture in September 1945, and suggestions for lecturers should be received by May 31, 1945, at the latest.

University of London Appointments

DR. L. S. PENROSE has been appointed to the Galton chair of eugenics tenable at University College. Since 1939 he has been attached to the Provincial Department of Health, Ontario, Canada, and in addition is a physician at the Ontario Hospital, lecturer in psychiatry in the University of Western Ontario, and medical statistician for the Province.

Dr. C. Rimington, who has been on the staff of the National Institute for Medical Research since 1937, has been appointed as from May 1 to the University chair of chemical pathology tenable at University College Hospital Medical School.

Announcements

WE regret to announce the following deaths:

The Earl of Balfour, P.C., chairman of the Cambridge committee of the Commission on the Universities of Oxford and Cambridge, on January 14, aged ninety-one.

Sir Thomas Barlow, Bart., K.C.V.O., F.R.S., president in 1910–15 of the Royal College of Physicians, on January 12, aged ninety-nine.

THE Committee of the Athenæum has elected the following, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services: the Right Hon. Lord Catto of Cairncross, governor of the Bank of England; Sir Bennett Melvill Jones, Francis Mond professor of aeronautical engineering, University of Cambridge, the Hon. John Gilbert Winant, ambassador of the United States to the Court of St. James's.

DR. DELLEPIANE RAWSON, an eminent plastic surgeon in the Argentine, has arrived in Britain for a six months visit arranged by the British Council. Dr. Rawson, who is head of the special ward for plastic and restorative surgery at the Hospital Rawson, Buenos Aires, and associate teacher at the Faculty of Medicine, will be working with Sir Harold Gillies in the Emergency Medical Service Plastic Surgery Unit at Park Prewett Hospital, Basingstoke.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Photographic Record of Follicular Keratosis

In the treatment of some types of skin disease, during which progress may be relatively slow, only slight changes in the appearance of the skin occur between successive examinations, even when these are spaced several weeks apart This makes the effect of the treatment difficult to observe visually. It has been suggested that a photographic method of recording the progress in such cases may be of value.

In the study of follicular keratosis (folliculosis), a special photographic technique is required to give a sufficiently good rendering of the texture of the skin, as in this case the irregularities of the surface are small in size, and do not differ appreciably in colour from the surrounding area. It is also necessary to devise an apparatus which will enable such a technique to be applied with all conditions kept constant so that any changes in the appearance of the skin will be shown readily

Various means of recording folliculosis photographically have been tried in this Laboratory, including the use of ultra-violet and infra-red, the most promising results so far have been obtained by the following methods :

(*a*) By illuminating the surface with a small point source, the light from which strikes it at a grazing angle of incidence, so that sharp shadows of the elevated areas on the skin are produced.

(*b*) By illumination at a more nearly vertical angle of incidence. In this case, as the shadows are much less pronounced, the film must be developed to a high degree of contrast to show the markings on the skin.

The two methods appear to be complementary, as certain details are shown up in one case which may not be seen in the other.

A portable apparatus has been developed using a Leica camera fitted with an extension tube to enable close-up photographs to be taken, by both methods of illumination. While the apparatus has been designed to minimize the relative movement between the patient and the camera, nevertheless the exposure time should be as short as possible to prevent the definition from being impaired by any involuntary movements of the patient. The camera lens must also be stopped down to a small aperture to give an adequate depth of focus, as the surface of the arm or leg under observation is usually rounded. For both reasons, a high level of illumination of the skin is required.

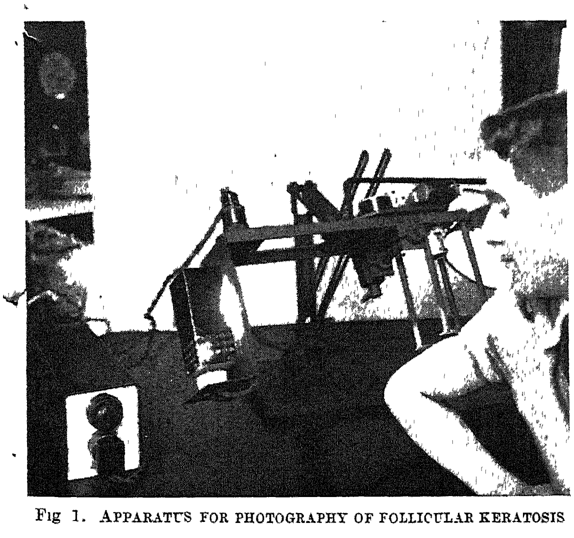

Fig 1. APPARATUS FOR PHOTOGRAPHY OF FOLLICULAR KERATOSIS

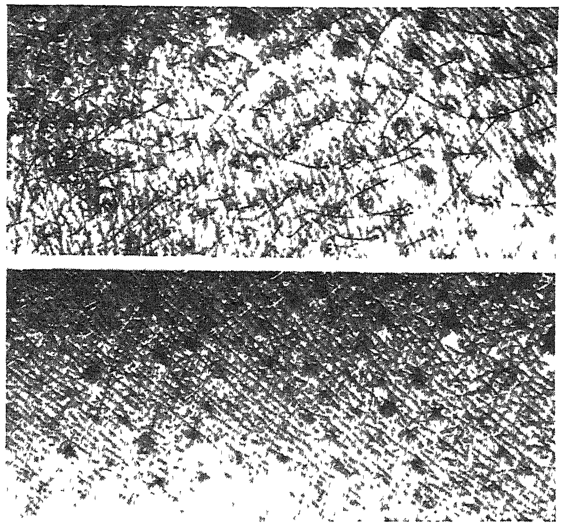

Fig 2 PHOTOGRAPHS OF FOLLICULAR KERATOSIS ON DARK SKIN ABOVE, FLAT LIGHTING, BELOW, OBLIQUE LIGHTING 1 6

A Mazda 250-watt box type *ME* lamp (a mercury vapour lamp with a small source of high brightness) is used as the source for oblique illumination, while a 250-watt photo-flood lamp mounted in a reflector provides the illumination for the second method Satisfactory exposures are obtained with 0·5 sec. at an aperture of $f \cdot 18$ with a panchromatic film having a speed of 23° Scheiner with oblique illumination. With the photo-flood lamp, which is about 6 inches from the surface of the skin, a similar exposure is quite satisfactory, using in this case Kodak Microfile film.

The conditions of lighting on the skin of the patient are kept constant by fixing the lamps in relation to the camera. A rectangular aperture covering the whole field of view of the camera is attached to it at such a distance from the lens that all within the field is in accurate focus. The lamps, camera and aperture are mounted on a framework which can be adjusted into any position. In using the apparatus, it is arranged so that the aperture surrounds, and its sides touch, the area of skin which is to be photographed.

The apparatus is shown in operation in Fig. 1, and some typical photographs taken with the two methods of lighting are shown in Fig. 2.

The experiments have been carried out at the request of Dr. Magee in collaboration with Dr. Hawes and Dr. Stannus, working for the Ministry of Health, who have kindly allowed the photographs to be published. Acknowledgement is also due to Mr. H. Warren, director of research, B.T.H. Company, for permission to publish this note.

H. K. BOURNE.

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby. Nov. 10.

Phase Difference Microscopy

I HAVE read with much interest the description by Mr. O. W. Richards of his own and his colleagues' recent work on Zernike's phase contrast method. Everyone who is interested in the microscopical observation of living cells should be grateful to him for having once again directed attention to its value as applied to microscopy. It possesses the advantage over ordinary trans-illumination that fine unstained structural detail is seen in greatest contrast by focusing exactly *on* the specimen, so that we may expect a closer geometrical correspondence between the appearance seen and what is 'really there'.

During the past eight years, Zernike's method has been regularly used in this Laboratory by Dr. C. R. Burch and by others whom he has interested and helped, both as a test for the accuracy of mirrors intended for astronomical and other purposes[1], and as applied to microscopy, including the microscopy of living cells[2].

Interesting new possibilities in the preparation of phase-contrast configurations, for example disks and strips, have lately been opened up by the development of the modern technique of controlled evaporation *in vacuo*. By this process, a transparent layer can be deposited on a thin glass plate of such a thickness as to increase by one quarter of a wave-length the retardation of yellow light passing through the plate. By drawing a fairly sharp stylus across this layer, we can remove the soft coating from a narrow strip of the glass without damaging the glass surface. The result is a 'phase-advancing strip' which can be used for phase-contrast testing in the same way as the phase-retarding disks and strips so ingeniously prepared by Dr. Burch.

A relatively easy way of producing such coatings is to leave the glass plate in a lens-blooming chamber, such as is now used by some optical firms, during five or six consecutive runs. This builds up a layer of approximately the desired thickness.

In an investigation into phase-contrast diffraction theory which I hope to publish shortly, I have shown that considerable variation can be allowed in both the thickness of the layer and the width of the strip without seriously reducing the efficiency of the method. No doubt this is one reason why the method is so successful in practice.

E. H. LINFOOT.

H. H. Wills Physical Laboratory,
University of Bristol.
Dec. 1.

[1] Burch, C. R., "On the Phase-Contrast Test of F. Zernike", *Mon. Not Roy Ast Soc*, **94**, 384 (1934). "On a Zonal Zernike Test for Paraboloids", *Mon. Not Roy Ast Soc.*, **95**, 548 (1935).
[2] Burch, C. R., and Stock, J P P, "Phase-Contrast Microscopy", *J Sci Instr*, **19**, 71 (1942)

Age of the Saline Series in the Salt Range of the Punjab

OUR evidence for the post-Cambrian age of the Saline Series, based upon microfossils in the rock-salt and marl, was already clear and ample[1,2]. It has since been greatly reinforced by the discovery, both at Khewra and Warchha, of similar fossils in dolomites, dolomitic limestones and shales belonging to the Series, which do not admit of the remotest suspicion that any foreign matter was washed in, faulted in or caught up by later earth movements.

Some of these more recent finds were reported to *Nature* in a communication dated July 21, but on the receipt, soon afterwards, of the issue containing the interesting note by Dr. G. M. Lees[3], we withheld publication until we should be in a position to offer fuller data, if possible after examining the Persian material kindly sent by him These specimens have not yet arrived, but meanwhile the *in situ* nature of our Khewra and Warchha material has been fully confirmed by Dr. H. L. Chhibber, who very kindly accompanied us to the Salt Range early in October this year, and who proposes to write a geological note on the localities in question.

(*a*) *Rock-salt and kallar*. Of the samples of rock-salt plus kallar newly collected, only two have yet been examined (coll. Sahni, Oct. 3, 1944, Mayo Mine Khewra): *K*4, from the Middle Pharwala seam in Chamber 19, showed several pieces of conifer wood with well-defined bordered pits, and some woody fibres; *K*5, from the Buggy seam in Pillar 47–48, 43 Incline, 2nd Sub-level North, brought forth a cuticle with two stomata, several shreds of wood and some chitinous remains

The winged insect from the Warchha marl, mentioned in a previous communication[4], has since been identified as a new extinct species of *Chironomus*, *C. primitivus* M. S. Mani[5]. This genus of Diptera had not so far been found in the Indian strata.

(*b*) *Dolomites and dolomitic limestones*. From the Warchha mine Mr. B. S. Lamba had sent to one of us a specimen of compact saline dolomite (Lamba, No. 7, Warchha, July 1944) taken from a stratum within the Saline Series as exposed in the New Low Level Tunnel, at least 1,500 ft. from the entrance. Treated with dilute hydrochloric acid, it released numerous shreds of pitted woody tissues, among them two pieces of conifer wood with bordered pits and medullary rays. A little dilute safranin placed on a thin slice of the rock at once picked out numerous specks of organic matter scattered through the crystalline matrix. During our recent visit the position of this dolomite within the Lower Gypsum Stage of the Series was confirmed. Specimens collected by ourselves are now being examined.

A piece of compact dolomitic limestone collected for us by Mr. Lamba from a stratum exposed in the New Low Level Tunnel at Khewra, 1,335 ft. from the entrance (Lamba No. 3, Khewra, July 1944), has yielded carbonized pitted tracheids and other woody tissues. We have, as before, been able to confirm the position of this stratum within the Saline Series.

A specimen of compact grey dolomitic limestone (coll. Sahni, Oct. 5, 1944, *W* 15) from the main body of the Warchha valley Oil Shale group exposed in the section figured as an 'anticline' by Reed, Cotter and Lahiri[6] has revealed several woody fragments

A finely laminated but compact grey dolomite collected last year from the outcrop of the Oil Shale group near the confluence of the Jarhanwala and Jansukh streams (Sahni, Oct. 13, 1943, *S* 21/1) was specially rich in angiosperm remains; for example, a beautifully preserved grass cuticle, shreds of wood, several types of pollen and a stellate hair, besides organic membranes of unknown affinity. This dolomitic band is an integral part of the Oil Shale series, with a dip and strike conformable with the rest of the strata in the group Further specimens, taken last October, are being analysed for their fossil content.

Oil Shale. From an outcrop near the same locality came a piece of dark grey Oil Shale (*S* 20), also collected in October 1943. It contained, among many other woody shreds, a gymnospermous tracheid with large elliptic bordered pits. This rock does not effervesce with hydrochloric acid; when heated it smells of petroleum and if kept longer in a flame it ignites, keeping alight even when removed. This particular bed could not be located last October, but other specimens of dark grey shales collected from within the Warchha valley Oil Shale series are being examined.

Some of the fossils here mentioned have been briefly described and figured elsewhere[7,8]. In a separate communication one of us hopes shortly to discuss the wider implications (practical as well as purely scientific) of the present work. Some of these conclusions, already suggested on independent grounds, have been set forth in important recent communications by Col. Davies[9], Dr. A. Lahiri[10], and Mr Lamba[11].

The simple approach which the microfossil technique offers to some of the intricate and long-standing problems of Salt Range geology lays bare in a striking manner its possibilities as an aid to stratigraphical work in general.

B. SAHNI.
B. S. TRIVEDI.

Department of Botany and Geology,
University of Lucknow.
Nov. 6.

[1] Sahni, B., *Nature*, **153**, 462 (1944)
[2] Sahni, B, and Trivedi, B S, *Nature*, **153**, 54 (1944).
[3] Lees, G M, *Nature*, **153**, 654 (1944).
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Chromatographic Separation of Coal Bitumens

INTEREST has long been focused on the so-called soluble coal bitumens, since Bone and Fischer demonstrated their influence on the coking characteristics of bituminous coals. Attention was specially directed towards the Fractions III and IV (Bone) of the high-pressure benzene extracts from coals. We need not recount the literature existing on the subject: but it is well known that there is no definite knowledge about the molecular nature of the coal bitumens except that they are complex mixtures. Recently, interest has been revived in the subject by Prof. H. L. Riley. From X-ray diffraction studies he suggests[1] that "the bitumen of the coal is responsible for the systematic variation in the *c* dimensions of the crystallites formed during carbonisation", and "It is therefore possible that the systematic variation of the *c* dimension is connected in some way with the coking phenomena". His researches have led him to investigate the carbonization characteristics of substances of known polycyclic structure. However that may be, it is clear that investigations on the constituents of the coal bitumens themselves would lead to a greater understanding of the subject if it were possible to isolate or at least resolve them into groups of substances of similar nature. Orthodox chemical methods have so far failed to resolve the components of coal bitumen. Although adsorption methods have been tried by some workers, it appears that no systematic application of the chromatographic technique (with all its vast elasticity) has yet been carried out. The only published example is recorded by Zechmeister and Frehden[2], who isolated a substance of the triterpene class from the light petroleum extract of a Hungarian lignite.

The chromatographic technique was tried and successfully applied by us in an effort to separate the high molecular weight oxidation products of oils. As many of the properties of these substances appeared to be similar to those of coal bitumens, samples of high-pressure benzene extracts of some coals were obtained from H.M. Fuel Research Station at Greenwich, and the fractions were subjected to chromatographic analyses. Results from preliminary experiments suggest that the problem of resolution of the bitumens into their components would yield to a systematic application of the ultra-chromatographic technique. The technique is simple and is as follows.

The sample (in this case Fraction IV of Mitchell Main Dull—the part soluble in boiling benzene) is dissolved in the solvent and a chromatogram is developed on a column of suitable adsorbent, and the zones eluted by means of selective eluants. In the chromatography of bitumen, development of a liquid chromatogram is by far the most satisfactory technique, as several members of a homologous series may be present showing no interspace on the chromatogram. In the chromatography of Fraction IV, we used silica gel as the adsorbent Sorbsil Gr. A (8–12 mesh) gel was crushed, treated with concentrated nitric acid for two hours on a steam bath, washed free from acid, graded by elutriation to 100–200 mesh size and cleaned with hot distilled water until completely acid-free. The gel was then dried at 110° C. in shallow dishes and activated for two hours at 250° C. before use. The adsorptive on the chromatogram has a uniform brown colour in ordinary light, and no recognition of zones is possible. Separation of the zones is, however, easily done by using ultra-violet radiation (364–400 A.), when distinctly different fluorescences of the adsorbate both on the column and in the eluate can be observed. Eluants of Analar quality and 'chromatographically' purified are used for development and elution. The fluorescence in the eluate is best observed in very dilute solutions, as concentration tends to quench the fluorescence. For record purposes we take natural-colour photographs in ultra-violet light.

In the development of a liquid chromatogram, selection of the eluants is, of course, the most crucial point. In the chromatography of Fraction IV of Mitchell Main Dull, for example, we have used the following solvents in the order stated: petroleum ether 60°–80° C. (aromatic-free); petroleum ether plus 10 per cent benzene, benzene, benzene with 1 per cent ethyl alcohol, benzene with 5 per cent ethyl alcohol, benzene with 20 per cent methyl alcohol, chloroform, carbon disulphide saturated with methyl alcohol, and a 50 : 50 mixture of pyridine and carbon disulphide with 10 per cent methyl alcohol. In other cases, ethyl ether, carbon tetrachloride, cyclohexane and, for more strongly adsorbed substances, methylene chloride and tetrahydrofurane are good eluants. Of

other adsorbents (specially for rechromatography) activated alumina and magnesia are suitable media Fullers earth (several types have been tried), florodine, etc., are not suitable media, for besides effecting polymerization of the resinous substances, they adsorb coloured substances too strongly.

Fifteen different fractions were separated with the first seven eluants in the case of Fraction IV (part soluble in boiling benzene): two fractions, first, resinous substances with very strong bluish-yellow fluorescence, and second, a substance with strong powder-blue fluorescence with petroleum ether, and petroleum ether plus 10 per cent benzene; three fractions with benzene, having bluish, greenish and milky yellow fluorescence: six fractions with benzene plus 1 per cent ethyl alcohol, including three brown rings (non-fluorescent) at regular intervals; one fraction with benzene plus 5 per cent ethyl alcohol; one with benzene plus 20 per cent methyl alcohol, one with chloroform; one with carbon disulphide plus methyl alcohol. At the end of elution with these solvents, the chromatogram is completely stripped of adsorbate, except for a black ring on the top, part of which can be dissolved in a mixture of pyridine and carbon disulphide (The fluorescence colours noted are all ultra-violet fluorescence colours.) Each of these fractions can be further resolved into several fractions by rechromatography on aluminium oxide and magnesium oxide

Applying similar technique, Fraction III of a Warwick Slate Bright coal sample has been separated into eleven fractions.

The behaviour of the fractions on the chromatogram indicates that the elution of the zones is a 'stripping' effect on the parts of a colloidal system, interspaces occurring between three groups which can be likened to the dispersing medium, protective colloids and micells of highly condensed carbonaceous substances. Interfacial tension is probably the main factor in the assembly, and therefore separation, of these substances.

Spectroscopic and other relevant data on the separated fractions are being collected and the complete analytical data will be published elsewhere in due course.

We wish to thank the Director of H.M. Fuel Research Station and Dr. H. L. Horton for making the benzene pressure-extracts available to us and Prof. W. F. K. Wynne-Jones for his helpful criticism and interest in the work.

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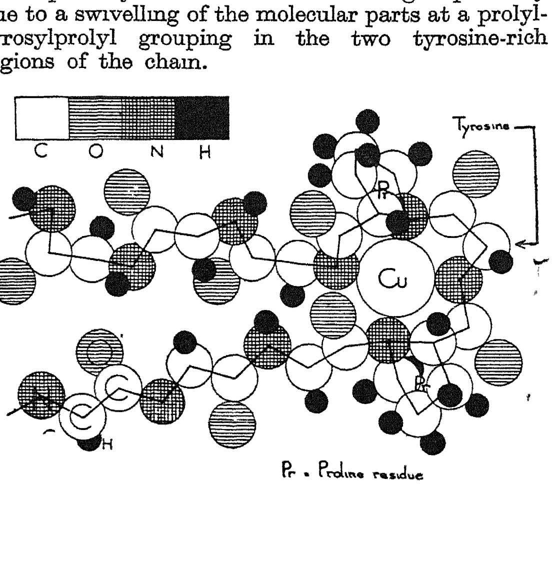
[1] *Proc. Roy. Inst. Chem.*, Pt. IV, 127 (Aug. 1944).
[2] *Nature*, **144**, 331 (1939).

Denaturation and Renaturation of Proteins

DESPITE the considerable advances that have been made in our knowledge of protein structure, the problem of denaturation remains somewhat obscure. A general theory of the phenomenon has been developed, which, although rough in its definition and speculative in character, is acceptable with varying degrees of qualification to most protein chemists. This theory supposes the uncoiling of a polypeptide chain (see, for example, Astbury and Lomax[1]); but so far direct evidence in support of it has been meagre and confused by experimental results that reflect chemical and physical reactions of secondary importance These reactions may be avoided to a large extent by the examination of a protein of the greatest possible simplicity of structure Silk fibroin, which is free from sulphur and contains a negligible number of amino- and carboxyl-groups, offers possibilities in this direction.

An earlier communication in *Nature*[2] indicated the possibility of renaturing silk fibroin, which normally occurs as a highly insoluble, fibrous protein. We have since found that the process of dissolution of fibroin in cupri-ethylenediamine, neutralization of the solution and dialysis, is attended, under suitable conditions, by complete renaturation of the protein. The optical activity, osmotic pressure, alkali-combining power, viscosity and tryptic digestion of the aqueous solution have been investigated, films of soluble fibroin have been prepared and examined by X-rays, and the analytical data for its constituent amino-acids have been extended The results obtained lead to the following tentative conclusions.

The molecules of fibroin consist of long chains (length about 1300 A; wt. 33,000) orientated parallel to the fibre axis. In its natural state the chains are in the almost fully extended configuration, corresponding to Astbury's β-keratin. They do not possess the regular periodicity of amino-acid distribution suggested by Bergmann and Niemann[3]; the greater part of the chain shows a regular periodicity, but there appear to be two regions, relatively small and symmetrically placed in the chain, that are rich in tyrosine, and include all of the four proline residues (Abderhalden and Bahn[4] isolated serylprolyltyrosylproline from fibroin). Adjacent chain molecules are linked by hydrogen bonds between opposing : CO and : NH groups of the peptide linkings. On dissolution of fibroin in cupri-ethylenediamine, these bonds are broken and each of the Cu-en groups combines with two proximate : NH groups along practically the whole length of the chain so that the whole molecular complex has a Cu : fibroin-N ratio of nearly 1 : 2 (the non-peptide-N in fibroin is very small). This complex formation occurs very rapidly and is followed by a slower reaction in which the chain folds back on itself at the two proline-containing centres to give a 3-limbed configuration (either as a lamina or a prism of axial ratio approx. 20 : 1). The extent of the folding is dependent on time and concentration of the cupri-ethylenediamine. This folding is probably due to a swivelling of the molecular parts at a prolyltyrosylprolyl grouping in the two tyrosine-rich regions of the chain.



A possible structure of the hinge is shown in the accompanying diagram, in which there are four donating nitrogen atoms (all in one plane) for one copper atom, the co-ordination number of six for the Cu being completed by two water molecules in place of ethylenediamine; the four nitrogen atoms are due to two proline, one tyrosine and one other amino-acid. The resemblance of this structure to hæmoglobin will be apparent. Neutralization of the cupri-ethylenediamine complex liberates the fibroin either in the completely renatured form (for which the name 'fibroinogen' is suggested) or as a mixture of renatured and denatured forms (both of molecular weight approximately 33,000) according to the conditions of dissolution. In the former case, dialysis affords a water-clear solution that gives no immediate precipitate on acidification and from which protein separates as a gel in the course of two or three days; in the latter, the solution is more opaque and stable for periods up to fourteen days, and acidification to *p*H 3 causes immediate precipitation of the denatured portion. It follows that the process of denaturation of fibroin is essentially an unfolding of molecular chains, which, in appropriate circumstances, is followed by their subsequent aggregation.

One point of special interest in the above folded chain is that apparently the β-keratin configuration of the chain itself is retained. For example, careful evaporation of a layer of aqueous solution of renatured fibroin leaves a water-soluble 'Cellophane'-like film that can be stretched when moistened to about three times its original length. The stretched film is completely insoluble in water and strongly birefringent, and gives X-ray diagrams (β-keratin structure) identical with that of the unstretched film and that from fibroin powder. This is contrary to the theory of Bailey, Astbury and Rudall[5] that denaturation (at least in a 'configurational' sense) is the conversion from the α- to the β-structure.

The degradation products of relatively high molecular weight, obtained by mild alkaline hydrolysis of fibroin, are insoluble in water and dilute acids and alkalis; they may be 'regenerated', however, to give water-soluble products. Should this regeneration involve a folding mechanism, then it follows that these degradation products exhibit true denaturation. On the other hand, it is possible that regeneration here implies merely a separation of molecular aggregates.

Fibroin thus provides an example of reversible denaturation in which not only is complete renaturation unequivocally demonstrable for the first time, but also the freedom from ancillary changes gives a clear picture of a molecular change that may serve as a basis for the general study of denaturation. With fibroin, denaturation consists simply of the unfolding of a molecular chain. The forces holding the folds in position are weak, and the unfolding readily occurs in aqueous solution. The straight chains thus formed are intrinsically soluble in water but, being no longer stabilized by intramolecular hydrogen bonds, they can only form hydrogen-bridges intermolecularly, that is, coagulation readily occurs. It is probable that this simple picture is not directly applicable to all proteins, the denaturation of most of which is attended by secondary reactions associated with thiol groups, extension of the molecular chain (α—β-keratin transformation), and other phenomena. The study of fibroin has, however, provided an explanation that, while admittedly not entirely novel, is in accord with the general theory of the solubility of macro-molecules (see Lieser[6]) and removes much of the vagueness that has been associated with a phenomenon of common occurrence and outstanding importance in protein chemistry.

A full account of this work will be published elsewhere in the near future

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[2] *Nature*, **146**, 301 (1940)
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Deaf-Mutism and Low Iodine Content of Water

The association of congenital deafness or mutism with districts where endemic goitre and cretinism are prevalent is well known[1-5]. It is now generally accepted that endemic goitre and cretinism occur among inhabitants of areas where the iodine content of the water is low, provided no other rich source of iodine such as sea fish is utilized[6]. Russell Brain[7] considered that many hereditary factors influence iodine utilization and that in congenital cases what is inherited is not goitre, cretinism or deaf-mutism as such, but rather some defect in iodine utilization. Hallpike[8] has pointed out that congenital deafness does not necessarily involve a congenital anatomical defect, but may depend on an inherited predisposition to degeneration of certain tissues and be precipitated by biological factors, which are identifiable and subject to control.

A considerable amount of information has now been collected about the position of areas where the iodine content of the water is low, and the occurrence of endemic goitre in Great Britain[9]. During these clinical investigations on the distribution of thyroid enlargement, the highest incidence of deaf-mutism was found in districts where endemic goitre is prevalent and cretinism exists. In contrast with the incidence of goitre, men are affected with congenital deaf-mutism as often as women. In some cases deaf-mutes show enlargement of the thyroid gland; in others there is a history of goitre in some other member of the same family.

Stocks[10], working on the records of the Board of Education Goitre Survey of 1924, found goitre markedly prevalent in north Oxfordshire, with a very high incidence for enlargement of the thyroid gland among children aged twelve in rural areas, for boys 11·39 per cent, for girls 37 22 per cent. He classed Berkshire as a non-goitrous county and recorded the low rates of enlargement of the thyroid gland among rural children aged twelve, for boys 0·83 per cent, for girls 3·88 per cent.

The Rev. H. M. Ainger, working for the Association for the Deaf and Dumb of the Oxford Diocese, which also includes Berkshire, has made personal inquiries about the place of birth, age and residence of deaf-mutes in these districts. Using the records of the above Association, it is possible to compare the incidence of deaf-mutism in different areas and

correlate it with the iodine content of the water supply.

In three districts of Oxfordshire, namely, Banbury, Chipping Norton and Woodstock, which comprise one area, there is endemic goitre, the water supplies are low in iodine (1·4–3·0 μgm. per litre), and the records showed 28 deaf-mutes in a total population of 36,653. In three districts of another area, Henley and Goring in Oxfordshire and Windsor in Berkshire, where endemic goitre is not prevalent and the iodine content of the water is moderate to high (10·1–52·2 μgm. per litre), there were five cases of deaf-mutism in a population of 38,910.

We have records of endemic cretinism in certain Oxfordshire villages; in two instances two members of the same family. Goitre existed in other members of these families. Ten deaf-mutes from low-iodine areas in Oxfordshire were examined radiologically, four men and six women of ages between 16 and 61 years. These people showed bone changes in the skull, but of no consistent pattern In some the deviation from the normal in the skeletal architecture was marked. The association of deaf-mutism with endemic goitre and cretinism in England supports clinical observations in other parts of the world.

It is suggested that a biological factor such as a low amount of available iodine, if associated with inherited defect in iodine utilization, may contribute to the incidence of congenital deafness For such families the provision of an additional source of iodine, such as iodized salt, is indicated.

We are indebted to Miss B. W. Simpson, Rowett Institute, for estimation of the iodine content of drinking waters, and to Dr. F. H. Kemp, Radcliffe Infirmary, Oxford, for radiological observations.

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Sources of London Honey

As a perfumery research chemist and also as a London beekeeper for some eighteen years, I would like to point out critically but constructively that there is but little relationship between the several pollens found in a honey and the bulk of the nectars from which the honey is derived. I have samples of London honeys going back for about five years. These all exhibit the peculiarities mentioned by Dr. Melville in his communication[1]. But as I have pointed out on several occasions in the lay press and elsewhere, from observation—and this will be endorsed by other London beekeepers—the bulk of the *main* honey flow from London (in particular the parks) is derived from the limes (*Tilia Europea*) and the privet hedges (*Ligustum vulgare*). Since the War, however, the prevalence of willow herb (*Epilobium angustifolium*) has served to modify the blend, producing ultimately a paler and sweeter honey. Some years there is also a substantial honey flow from horse-chestnut, sycamore and maple; but coming early in the year, these nectars are mainly consumed in brood-rearing and not stored

My research into the flavours of honeys brought me into contact some ten years ago with Mr. E. K. Nelson, of the Bureau of Chemistry and Soils, Wood Research Division, Washington, who was able to establish the presence of methyl anthranilate in orange blossom honey and thus to identify a definite flavour. More recently, Mr Pryce Jones and I have been investigating the peculiar bitterness of lime nectar. The cat-like odour referred to by Dr. Melville, which is also associated with the flowers and leaves of *Ribes*, is, I think, unquestionably due to privet, since it can be readily detected in country-gathered honeys when privet or wild privet prevails in the vicinity, but where *Ailanthus* is usually absent. Moreover, in Marketing Leaflet No. 31 (Ministry of Agriculture and Fisheries), "Honey-Grading and Marketing", privet is given specific prominence as an unpleasant natural *taint* to be guarded against. Incidentally, *Ailanthus* (*glandulosa*) smells of mice. I have had some experience with this tree as I grew quite a lot of it both outside and under glass at Purley Park, Berks. It is the natural food plant of the Chinese ailanthus silkworm (*Philosamia Cynthia*) which I reared in large numbers before my unsuccessful endeavour to acclimatize it in Battersea Park, fifteen years ago. The larva does not smell, but the newly emerged moth smells strongly of mice. The *Ailanthus* by no means always flowers successfully, and according to Wedmore, even in California it is only considered of secondary importance for honey, and even that is of a poor flavour.

My present apiary, consisting of twelve stocks in the Gardens of the Zoological Society, Regent's Park, furnished me with a crop which, as a beekeeper, I am quite sure was gathered from horse-chestnut, willow herb, privet and lime; and yet a pollen analysis by Mr. Yate Allen revealed the following bewildering variety:

Red or black currant (*Ribes rubra vel nigra*)	20
Lilies (Liliaceæ)	15
Aubretia (*Aubretia*)	7
Laurel (*Prunus Laurocerasus*)	7
Poppy (*Papaver*)	6
Hyacinth (*Hyacinthus*)	6
Tulip (*Tulipa*)	6
Asters (Compositæ spp)	6
Lime (*Tilia*)	5
Willowherb (*Epilobium*)	5
Hollyhock (Malvaceæ)	5
Indeterminate—other flowers	12
	100

In a private communication received from Mr. Yate Allen in October, he says: "As I have pointed out on many occasions in lectures or writing, there are all sorts of pollen which get into the honey which have no relation to the nectar, such as the pollen from grass, poppies, plantain, etc., which produce no nectar at all. Then again, there are a lot of nectar-producing flowers which produce very little pollen, while others produce it copiously. Limes, partly due to their pendulous position, produce very little pollen. Hence if bees also had access to some of the cruciferous flowers, one might find a sample of nearly pure lime honey to contain the largest percentage of grass, Plantago, and crucifers."

Todd and Vansell[2] have shown by a series of experiments by collecting nectar from flowers with a pipette and also by analysis on the contents of the bee's honey stomach that not only do the number of pollen grains vary enormously with each species of plant, but also that they are in a large part removed while still in the honey sack of the bee by the action of the honey stopper into the ventriculus. The quantity removed depends on the length of time the bee spends on its gathering trip.

In conclusion, it may be said that whereas a pollen analysis of honey usually reveals its country of origin, only a chemical analysis can hope to reveal the sources of the nectars in its composition. I have a honey produced this summer in Hertfordshire showing a pollen count of 81 per cent *Castanea sativa* (sweet chestnut), if this should be of interest.

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[1] *Nature*, 154, 640 (1944).
[2] *J Econ. Entom*, 35, 728 (1942).

Honey from *Ailanthus*

THE attraction of hive-bees to the flowers of the Tree of Heaven, recorded by Dr. R. Melville in *Nature* recently[1], has also been noted by me in Oxford. On July 14, 1944, I was awakened at dawn by a continuous high-pitched whining hum, like that of a dynamo, in the tall trees outside this Museum, and found it to be caused by thousands of *Apis mellifica* which were visiting the male flowers. The latter are obscure and small-petalled, in large panicles, and give off a strong musky scent. Dr. Nicholas Polunin, who kindly identified the flowers as *Ailanthus altissima* (Mill.) Swingle, remarked that this kind of disagreeable smell is more commonly associated with fly-pollinated flowers such as certain Umbelliferæ. But I searched several branches at different times of day, and found practically no winged insects on the flowers except hive-bees, apart from a few small ladybird beetles.

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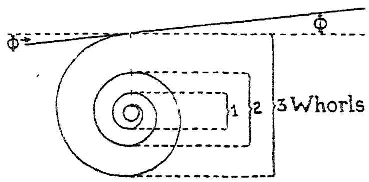
[1] *Nature*, 154, 640 (1944).

Classification of Spiral Foraminifera

THE members of certain pairs of foraminiferal genera (*Nummulites* and *Operculinoides*, *Assilina* and *Operculina*, etc.) with flat spiral tests are distinguished from each other only by the rates (or angles) of opening of their spires. It therefore seems anomalous that no ruling exists as a guide in separating forms after this manner; for although the right allocation is often obvious, there are intermediate forms which might, at present, be as legitimately referred to one genus as to the other, in each of these pairs.

In order to suggest a criterion, I propose that a spire should be regarded as wide-angled if it doubles its diameter with each revolution. This criterion is easily applied when examining sections (whether equatorial or meridian), and represents a roughly intermediate degree between forms now separated by spiral angles alone. If this criterion (or some other, for the one proposed has no inherent virtue beyond the convenience of the round figure 2) were generally adopted, it would secure more precision than now exists. I would also suggest, for this proposed critical rate of opening, the symbol $2d$, as signifying its doubling of the diameter with each revolution. An illustration of a uniform spire with this rate of opening is reproduced herewith.



All other rates could be similarly defined: thus spires would have the symbols $1 \cdot 7d$, $2 \cdot 5d$ or $3 \cdot 2d$ if, and so long as, their diameters increased by 70 per cent, 150 per cent or 220 per cent respectively, with each whorl.

Again, since foraminiferal spires are seldom constant for long, this convention would also enable one to define their variations, whether individual or ontogenetic. Thus one could say, of a certain species, that the rate of opening of its spire, at a given radius, varied from $1 \cdot 5d$ to $1 \cdot 8d$, and closed to about $1 \cdot 4d$ at a later stated radius. It would thus be possible to give actual values to what at present can only be suggested in general terms—'very variable', 'becoming more crowded', etc.—besides enabling one to define the differences between spires better than has hitherto been possible.

I understand that, so long as a given rate of diameter increase is maintained, the outline of the whorls concerned may be represented by the equation $r = ce^{\alpha\theta}$, where r is the length of the radius vector, drawn from the centre of the spiral, c is the length of some initial radius also drawn from that centre, α is the index of the rate of opening, e is the base of Napierian logarithms, and θ is the angle made by the vector with the initial radius. The 'opening angle' (Φ in the diagram) is then $\tan^{-1}\alpha$, and either Φ or α may be taken as characteristic of the degree of openness of the spiral.

If the rate of increase is 2, then $\alpha = \log_e 2/2\pi = 0 \cdot 1103$, and Φ is approximately $6 \cdot 3°$. Thus the critical rate of opening, for a wide-angled flat spiral whorl, could be taken as $6 \cdot 3°$, the practical test for that rate being the doubling of the diameter by the whorl.

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Specimens of *Asterias rubens* L. with Ten Tiedemann's Bodies

IT is well known that, in *Asterias rubens* L., nine Tiedemann's bodies are normally found. Elsewhere[1] I have previously recorded the occurrence of specimens with ten of these bodies, and have shown that the absence of the tenth (the presence of which makes the arrangement quite regular) cannot be accounted for by supposing that it is suppressed in order to 'make way for' the stone canal.

Since my previous note, the specimens of *Asterias rubens* used in the ordinary classwork of this Department have been carefully examined to see if further examples occurred and several have been found.

In my first note I recorded two out of twenty-five specimens which had this abnormality, and since then another eighty specimens have been examined of which four had ten Tiedemann's bodies. It would appear, therefore, that this condition may be expected in about 6 per cent of specimens, a slightly lower percentage than was previously suggested.

I should be glad to receive information as to whether this condition has been found by others. Negative reports would be as interesting as positive ones. The source of supply would also be a matter of interest.

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[1] *Ann Mag Nat Hist*, xi, 8, 61 (1941)

Observations on Bird Behaviour

WITH regard to the letters about birds pecking at windows and apparently attacking their own reflexions, it seems, judging from the reports of Dr. Britton, Messrs. Stephenson and Stewart, and Miss Frances Pitt, that this behaviour is considered to be confined mainly, if not entirely, to cock birds. At least, no mention is made in the correspondence of females behaving in this manner.

At present, there is a hen chaffinch in my garden that frequently pecks at the dining-room window. She has been doing this for five days now, and her pecking periods are astonishingly regular: 8.45–9.5 a.m., 11.30–11.50 a.m., 3.10–3.20 p.m, 3.45–4 p.m.; during these periods, but not of course continually during the period, she will peck at the window. At other times, even though she may be at the bird table near the window, she ignores the glass. The dining-room is a long room with three big windows, each latticed. The same window and the same pane of glass is chosen each time. There can, in this case, be no question of territory defence.

The habit is widespread among birds. I have records of its occurrence in blackbirds, song-thrushes, missel-thrushes, house-sparrows, robins, chaffinches, greenfinches, pied wagtails, grey wagtails, blue-tits, great-tits, cole-tits, spotted flycatchers, starlings and jackdaws. Miss Pitt's record of a dipper is most interesting.

I can offer no explanation of the behaviour. I do not think that territory has anything to do with it—at least in the vast majority of cases. In one case, however, I think the tapping was intelligent behaviour designed to attract the attention of the humans in the room. During the very cold spell of early 1940, we would put food out on various tables round the house (I was then living near Winchester) and especially on a long plank running outside the billiard room. A great-tit frequented this 'table' and would drive all other birds, including a robin, away. If the plank was bare, he would stand and chirp and then fly at the window, striking it sharply, then back to chirp, then fly to strike, and so on. When food was put out he stopped. This particular bird was very tame—tamer than any of the others, most of which would feed from the hand—and would fly to and sit on my shoulder, remaining there even if I walked indoors, but leaving if anyone approached

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E. M. Stephenson and Chas. Stewart describe certain actions of a sparrow in what many students of animal behaviour would call somewhat anthropomorphic terms[1]. They then remark that: "It is usually stated that all bird behaviour is instinctive. Much of it can, of course, be adequately described by this term. It seems inadequate, however, to speak as though the whole of animal behaviour . . . can be classified under one of two terms—instinct or intelligence. Such stultified and obsolete terminology has long since been advanced upon by the psychologist dealing with human behaviour." But, by most modern animal psychologists such stultified and obsolete terminology is not employed. It seems, moreover, doubtful whether the study of animal behaviour would necessarily be advanced if, as suggested, investigators used "terms for all the grades of specific psychic phenomena", whether the word 'psychic' be used 'legitimately' or not.

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[1] *Nature*, 154, 801 (1944)

Open Packing of Spheres

SOME automatic and continuous coal-weighing apparatus make use of the experimental fact that graded-to-size coal weighs the same per unit volume whatever the size of the lumps; hence a cubic foot of large lump coal weighs the same as a cubic foot of small lump coal.

This is easily proved. Let n be the number of spheres in one foot length; then if there are n^2 spheres in each layer, the total number of spheres in 1 cub. ft. is n^3 and the radius of each sphere is $\frac{1}{2n}$ ft. and its volume is $\frac{4}{3}\pi\left(\frac{1}{2n}\right)^3 = \frac{\pi}{6n^3}$ cub. ft., and as there are n^3 spheres, the total volume of the spheres in 1 cub. ft. is $\frac{\pi}{6} = 0{\cdot}5\dot{2}4$; that is, a little more than half is coal, and less than half is voids. As neither n nor r occurs in the expression for the volume, the number and size of the spheres do not affect the weight per cubic foot. This holds good only for the packing implied. If the closest packing is adopted, then the percentage of solids (density) increases as the size of the spheres decreases.

If the packing is such that one sphere touches eight others, then it can be shown that for spheres 1 in. in diameter, the total number in a 10-in. cube is 1,205, and the ratio of the volume of the spheres to a 10-in. cube is 0·631; while if the spheres are 2 in. in diameter, the total number is 132 and the density is 0·553; and if there are 40 spheres in the 10-in. edge, the total number of spheres is 87,388 and the density is 0·715.

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RESEARCH ITEMS

Preparation of Epidemic Typhus Vaccine

A. P BERKOWITZ (*S. Afric. J Med. Sci.*, 9, 109, 1944) has investigated the suitability of duck and turkey eggs for the large-scale preparation of epidemic typhus vaccine Duck embryos live longer (8–9 days) after inoculation than chick embryo do (6–7 days) The growth of rickettsiæ in the yolk sac of the duck egg is far more prolific than in the yolk sac of the hen's egg; and the duck egg's yolk sac at the stage used (15–16 days old) is about twice as big as that of a 13–14 day hen's egg Duck eggs inoculated by Cox's method gave, on the 7–8th day after inoculation with a South African strain of epidemic typhus, an average yield of 100–200 c c. of vaccine, which is about five times the yield of hen's eggs Stained smears show, in a high percentage of yolk sacs, an almost confluent sheet of rickettsiæ, "quite beyond anything seen even in the most heavily infected hen's eggs". Because the yield per yolk sac is so high, the residual proteins are correspondingly diluted, so that processing is easier. Preliminary protection tests in guinea pigs have indicated that the protective value of the duck egg vaccine is at least equal to that of the hen egg vaccine. A Middle East strain of epidemic typhus gave a similar extremely prolific growth in duck eggs. In turkey eggs the growth was just as prolific, and the yield of vaccine as great. It was found that the best conditions for primary incubation of duck eggs were a temperature of 102° F. in a completely humid atmosphere.

Biology of a Hymenopterous Parasite

THE *Journal of Agricultural Research* (69, Aug 15, 1944) contains a paper by D. W. Clancy of the U.S. Department of Entomology and Plant Quarantine dealing with the parasite *Allotropa burrelli* Mues. This insect is a member of the family Platygasteridæ and parasitizes the mealy bug known as *Pseudococcus comstocki* (Kun.), which has recently become a serious pest of apple in parts of Virginia, West Virginia and Ohio. The parasite was introduced into the United States from Japan in 1939 with the object of aiding the control of the pest already mentioned. It appears that the development of the parasite in the host is normally monoembryonic, although twinning may rarely occur. There is only a single larval instar and the larva bears but one pair of spiracles which is located on the first segment. Three twin embryos were found out of the hundreds that were examined. Two of these were early morulæ each with a separate trophamniotic layer, tightly enclosed in a membrane probably derived from the surrounding tissues of the host. The third pair was more advanced, and since both embryos were enclosed in a single trophamnion there seems no doubt in this case that they were derived from a single egg. It appears, therefore, that a very simple type of polyembryony may occur in rare circumstances The details of the process are very much the same as have been described by Leiby and Hill in *Platygaster hiemelis*.

Characin Fishes from Venezuela

LEONARD P. SCHULTZ has recently reviewed the catfishes of Venezuela. The present report is a companion to this work, being the second contribution on the fishes of Venezuela resulting from the author's expedition to that country to study the fish fauna, mostly of the Maracaibo Basin, during February–May 1942 ("The Fishes of the Family Characinidæ from Venezuela with Descriptions of Seventeen New Forms", *Proc. U.S. Nat Mus*, 95, No. 3181, Washington, 1944). The previous report (*ibid.*, 94, No. 3172: 1944) gives details of stations, etc., where specimens were collected. This family consists of freshwater fishes found in both Africa and South America, and is most closely related to the Nematognathi or catfishes and to the Cyprinidæ. An artificial key is given to the many genera and also in most cases keys to the species Recently, George Sprague Myers has described a new genus and species of Characid fishes from the Rio Negro, Brazil. for which he proposes the name *Rhinobracyon negrensis* (*Proc Calif. Acad Sci.*, iv, 23. No. 39, 1944). This he regards as a close relative of *Bryconamericus*, the generic characters, however, being well defined.

Vegetation of the South Brazilian Plains

AN interesting paper, "Profundidade dos solos e vegetação em campos cerrados do Brasil meridional", by Felix Rawitscher, Mario G. Ferri and Mercedes Rachid (*An. Acad. Bras. Cien.*, 15; 1943), is a continuation of studies published in the same journal in 1942. An examination of the water balance of *campos cerrados* (the fields in Emas, near Pirassununga, present the typical vegetation of the *cerrados*) led to the following conclusions: (1) The water content of the soil is high, as a number of tables show, and the underground water-level occurs at a depth of 17–18 metres. (2) The vegetation consists of plants which grow only during the rainy season, and Gramineæ with superficial roots which wither when there is a lack of water. There were also shrubs and smaller trees with very deep roots, many of which remain green during the whole dry period. (3) A number of experiments in rapid weighing, infiltrations, etc., showed that the stomata were open during the whole day and that the saturation deficit of the leaves was always small. The behaviour of the plants was not that of xerophytic vegetation, a fact in accordance with the great water reserves available to the plants. (4) The daily values of transpiration and evaporation are smaller than has been generally supposed, and the "campos cerrados" of the type studied do not present arid conditions, as is usually implied when they are included among the savannas. The arid appearance is due to annual fires, and the effects of dryness are limited to the surface only.

Diazocyanides

As is well known, Hantzsch regarded the isomeric diazohydroxides, sulphonates, and cyanides as *syn*- and *anti*-geometrical isomers H. H. Hodgson and E. Marsden (*J. Chem. Soc*, 470; 1943) showed that the so-called *syn*- and *anti*-diazosulphonates are not geometrical but structural isomers, namely, diazosulphites and diazosulphonates, respectively. The same authors (*J. Chem. Soc.*, 395; 1944) have now presented evidence indicating that the aryl so-called *syn*- and *anti*-diazocyanides are also structural isomers, namely, *iso*nitrile and nitrile structures, containing N—N and N—C bonds in the molecule. The conversion of the non-coupling *p*-nitrobenzenediazocarbonamide with a stable C—N bond, by reaction with bromine, into an N-bromocarbonamide, which will then couple with α- or β-naphthylamine in non-aqueous media, as also with β naphthol in aqueous alcoholic and alkaline solution, indicates that Hofmann reaction has occurred, and that the intermediate

diazotate with its easily ruptured N—N bond will couple. Other lines of evidence in support of their view are given by the authors. Hantzsch's formulation of the aryl *syn*-diazocyanides as NR=N—C≡N is regarded as correct, but the supposed *anti*-form is the *iso*cyanide $NR=N-\overset{+}{N}\equiv\overline{C}$, the two thus containing central N—C and N—N links, respectively, as stated above. The correctness of Hantzsch's formulation has, of course, been questioned many times before, but the new evidence is interesting.

Stability of Ascorbic Acid

AN investigation of the effect of conditions of storage on the stability of ascorbic acid in various foods, etc, carried out by J. B Marshall, J. W. Hopkins and G. A. Young (*Canad. J. Res.*, 22, 39, 1944), showed that jams to which ascorbic acid had been added after processing, and a natural orange concentrate, retained 70–80 per cent of the ascorbic acid on storage for periods up to a year when protected from moist conditions 'Fortified' jams retained 75 per cent after six months at 23·9° C. When exposed to conditions of high relative humidity and temperature the products became objectionable from the point of view of physical appearance before the ascorbic acid losses became excessive.

Impedance Measurement at High Radio Frequencies

AT a meeting of the Radio Section of the Institution of Electrical Engineers on December 6, L. Essen read a paper describing methods and apparatus, developed in the Radio Department of the National Physical Laboratory, for the measurement of both balanced and unbalanced impedances at frequencies between 375 and 750 mc./s. The equipment consists of an air-spaced concentric line for unbalanced impedances and a screened twin line for balanced impedances. The method is based on the principle described by R. A. Chipman in 1939, and consists in varying the length of line by means of a movable bridge carrying a thermojunction unit to determine the positions of current resonance. The component to be measured is connected to the open end of the line, and the impedance is evaluated from the readings of resonant length and the width of the resonance curve. Convenient working equations are developed by Dr. Essen, who also describes the results of a number of measurements made to check the validity of the assumptions involved. The main application of the apparatus has so far been to the determination of the propagation constants of radio-frequency cables, these constants being deduced from the values of the input impedance of a length of the cable under different conditions. By a suitable choice of the conditions of measurement, the effect on the input impedance of the discontinuity at the junction of the measuring line and the cable can be measured and practically eliminated. From the considerable experience obtained in the use of these methods during the past three years, the accuracies achieved for a wide range of reactance and resistance values are found to be ± 2 per cent and ± 5 per cent respectively.

Long Duration of the Balmer Spectrum in Excited Hydrogen

CURRENT theories and experimental determinations of the time of relaxation of the hydrogen atom lead one to expect that in about 10^{-8} sec. the intensity of light of a condenser discharge through hydrogen emitting the Balmer series of lines would diminish in the ratio $e:1$. Lord Rayleigh (*Proc. Roy. Soc.*, A, 183, 26; 1944) reports experimental determinations in which hydrogen, made luminous by a powerful discharge, is blown out of the electric field by thermal expansion In some experiments the time in question is one thousand times greater than the expected value. As the discrepancy is not cleared up, the results are reported in sufficient detail for critical examination.

Molecular Structure of Dielectrics

IN a paper entitled "An Elementary Description of Some Molecular Concepts of the Structure of Dielectrics" (*J. Inst. Elec. Eng.*, 91, Part 1, No. 48; Dec. 1944), E. B. Moullin gives an account of some of the atomic and molecular concepts necessary for the formation of a model that will give a rational description of certain behaviour of dielectrics. The dielectric constant of many materials is found to depend on the radius of the molecule, and the phenomenon of permittivity can be included in the inverse-square law of force between charges if the molecules can be supposed to exhibit an effect equivalent to that of electrostatic induction. Dr. Moullin gives an outline of the Bohr atom and the electronic theory of valency, and this provides a mechanism equivalent to induction as well as one whereby it is to be expected that certain molecules possess a permanent electric moment, which molecules are shown by direct experiment to be electric dipoles. A graphic description is given of the manner in which dipoles must produce heat when the dielectric is in an alternating electric field. The paper closes with a brief description of certain experiments which have been designed and made to show that molecular dipoles are a cause of dielectric losses, and a brief discussion of whether they are the main cause of the losses experienced in the insulating materials commonly used in electrotechnology.

Division Errors of a Reversible Transit Circle

Sir Harold Spencer Jones, the Astronomer Royal, and R. T. Cullen have determined the division errors of the fixed circle of the reversible transit circle of the Royal Observatory, Greenwich (*Mon. Not. Roy. Astro. Soc.*, 104, 4; 1944). The fixed circle was not divided on an automatic dividing machine, as is usual with large circles, but by a new "method of division by generation" which was devised by Messrs. Cooke, Troughton and Simms, Ltd, and this method was expected to give smaller division errors. In the case of circles divided on automatic dividing machines, it has generally been assumed that division errors could be represented as a sum of periodic terms, but as such an assumption would not necessarily be valid for the new method, a programme was arranged to determine the error of each division without any assumptions. A full description of the method, which occupies eighteen pages, is given. It was found that the analysis of the division errors showed a cyclic but irregular variation of 2½° period and that the form depended on the position in the circle. The 0°–90° section resembles the 90°–120° section, and the 30°–60° resembles the 60°–90°. When the 2½° variation was removed, periodicities of 15°, 30° and 60° appeared, and it is possible that the remaining fluctuations were due to accidental errors of detection or of dividing. The error of each of the 5′ graduation marks over an arc of 120° was determined with a probable error of ± 0·028″.

ELECTROCHEMICAL PROPERTIES OF SILICIC ACID SOLS

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THE properties of silicic acid sols have been studied by several investigators[1-10]. Differences of opinion[1 2 3] have been expressed as to whether the sols possess any intrinsic acid character. In a number of publications from this laboratory the interactions of silicic acid sols with bases[11 12,13 14], neutral salts[15 16] and acids[17 18] have been discussed. The sols even after purification by prolonged electrodialysis have free acidities of the order of 10^{-4} N. Their ultra-filtrates have a practically neutral reaction showing that mobile H^+ ions associated with the colloidal particles give rise to the observed free acidity of the sol.

The titration curves (Fig. 1) of the sols with dilute bases show an inflexion (first inflexion) in the acid region[12,13] at pH 4·5–5·5. This inflexion cannot be referred to the neutralization of any dissolved acid present in the sol, as the ultrafiltrate has negligible free and total acidities. The total acid neutralized by several dilute bases at this inflexion point is a constant quantity. The slopes of the titration curves, however, indicate the order $Ca(OH)_2 > Ba(OH)_2 > NaOH$ of the intensity of reaction of the various bases with the sol. The 'irregular or specific' cation effect observed with hydrogen clays[12 20] is indicated by this order.

With increasing concentrations of caustic soda a continued buffer action beyond the first inflexion point takes place, and a second inflexion (Fig. 2) between pH 11·0 and 11·7 corresponding to the formation of $NaHSiO_3$ is observed[13]. An inflexion at pH 11·8 in the titration curves of silicic acid sol with concentrated alkali has been observed by Treadwell and Konig[4]. The plot of the buffer capacity $\beta \left(= \frac{\Delta B}{\Delta p\text{H}}\right)$ against the concentration of the alkali shows a maximum near the point of half neutralization, indicating that up to the second inflexion only the first stage of neutralization of H_2SiO_3 is reached. The maximum value of the buffer capacity does not occur exactly at the point of half neutralization.

The sol behaves as a strong acid as judged from (a) the form of the titration curves with small additions of very dilute bases; and (b) by the manner of variations[14] with dilution and temperature of the free acid and the total acid at the first inflexion point. The free and total acids decrease almost linearly with dilution (from 0·3 gm. per litre to 0·04 gm. per litre) and do not materially change with temperature within the range 1°–50° C. A weak acid character of the sol is indicated (a) by the buffering in the range pH 6–8 beyond the first inflexion; (b) by the comparatively low ratio (0·5–0·8) of the free acid to total acid at the first inflexion, which is of the order of 10^{-4} N; and (c) by the manner of the variation of the pH of the sol on the addition of acids. A smaller lowering in the pH is observed[18] on the addition of a given concentration of an acid to the sol than when added to hydrochloric acid of nearly the same pH as the sol.

The dissociation constant calculated from different points of the titration curve with a dilute base on the basis of the total acidity at the first inflexion

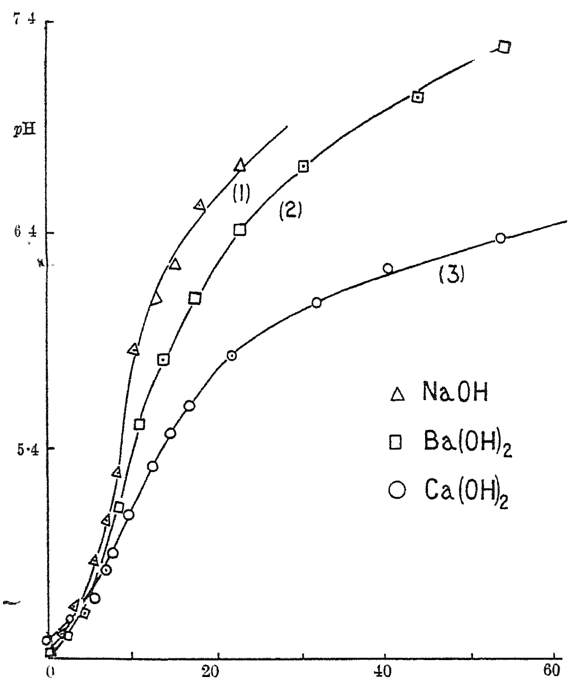

Fig. 1. SILICIC ACID SOL M.

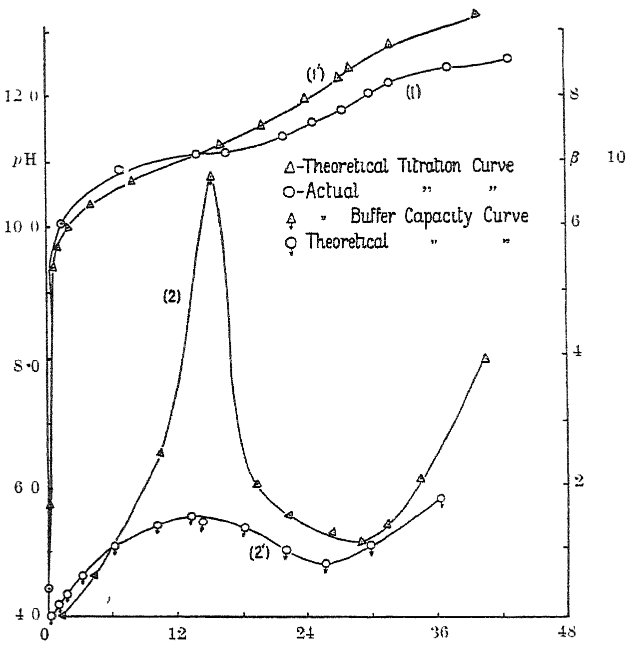

FIG 2 SILICIC ACID SOL L' THE THEORETICAL CURVES REFER TO THOSE OF A HYPOTHETICAL ACID HAVING THE SAME TOTAL ACTIVITY (OR SECOND INFLEXION) AND pK AS THE SOL.

point has different values[13]. The pK values calculated from the pH at the point of half neutralization in the titration curves with concentrated alkalis decrease with a decrease in the silica content of the sol The dissociation constant calculated from the pH at the second inflexion and from a consideration of the solubility of silicic acid varies from $4 \cdot 4 \times 10^{-10}$ to $5 \cdot 9 \times 10^{-10}$ with different sols and is found within the range (10^{-9}–10^{-10}) observed by previous workers[5,6,7,8].

The amounts of acid liberated from the sol by neutral salts as shown by the diminution in its pH[15,16] on the addition of salts and by the total amount of acid[16] found in the salt extracts are in the order: $Ba^{++} > Ca^{++} > K^{+} > Na^{+} > Li^{+}$, which follows the lyotrope series and illustrates what has been designated[12,20] as the 'regular cation effect'. The greater relative effect of Ba^{++} ions compared with Ca^{++} ions is definitely against the explanation that the development of acidity is due to the formation of insoluble silicates[9,10], since calcium silicate is more insoluble than barium silicate. The order, on the other hand, follows from an electrical adsorption of the cations together with their hydration envelopes.

The amount of acid liberated by continually leaching the sol with a definite concentration of a neutral salt diminishes[16] to an almost negligible value as the leaching progresses. The total amount of acid thus liberated, especially by barium and calcium chlorides, is considerably greater than that neutralized at the first inflexion point in the titration curve with a dilute base. This indicates that 'bound' H^{+} ions[19] are present in addition to those which can react with the base at the first inflexion point. The total quantity of the so-called salt that is formed by continued leaching of the sol with a solution of neutral salt is a small fraction (0 13 per cent) of the number of moles of silicon dioxide present (cf. also Moltschanowa[10]), indicating that the reaction with the salt is limited to the surface and does not appear to lead to the formation of a second solid phase.

At very low concentrations the alkali metal cations cannot easily displace the 'bound' H^{+} ions associated with the colloidal particles, but only effect an osmotic displacement of the mobile H^{+} ions[16]. With lithium chloride the displacement of mobile H^{+} ions is complete at a concentration of 0 01 N.

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SCIENCE IN THE MODERN STATE

MR. H. S. MORRISON'S L. T. Hobhouse Memorial Trust Lecture, which was read on his behalf by the Provost of University College, London, at Cambridge on May 9, 1944, has now been published under the title "Science and Administration in Modern Government" (London: Oxford University Press. Pp. 20 2*s*. net) The lecture is concerned mainly with the part which science can and must play in our affairs after the War if we are to survive and progress as a community, and more especially with social research or social engineering. Mr Morrison emphasized first the speed of scientific development at the present time and the scale upon which much of it proceeds. War-time experience seems to have established that there is no reason in the nature of things why Britain, admittedly a leader in fundamental research, should be any less good in the sphere of development and application; secondly, progress in the theoretical and practical solution of specific problems can be incredibly quick when 'all the brakes are off', and the object is not to serve the *status quo* but to surpass it as rapidly and as far as possible, and thirdly, that science as a method can be applied to almost any problem, however unlikely, and almost any material, however apparently intractable.

With regard to the first point, Mr. Morrison urged that we must reduce the risk of important and fundamental British inventions being developed abroad and then brought back in the form of finished and patented processes upon which the British manufacturer must pay a substantial royalty if he wishes to use them. The second lesson, the possibility of accelerating the rate of progress by removing obstacles, takes us deep into questions of economic and industrial policy, and Mr. Morrison pointed out that every large change in the social and economic sphere has its costs as well as its advantages; the calculation which has to be made will not necessarily show a result favourable to immediate change. It should, however, be our practice as a community to write off our existing capital assets at a good rapid rate; but it should not, he urged, be left to the unaided devices of large firms to calculate whether a certain change is justifiable or not. The calculation 'to scrap or not to scrap' may yield one answer to the company accountant and another answer to the Chancellor of the Exchequer. We ought to bear in mind, in considering the appropriate form of relationship between the State and industry after the War, the importance of ensuring that public policy is effectively operative when great and vital decisions affecting our industrial progress are being taken.

After referring here to the possibilities of scientific development of the supplies of coal, oil and sugar within the British Commonwealth, and to the possibilities of biological development as indicated by penicillin, biological control of plant, insect and animal life, including the biological use of X-rays, Mr. Morrison illustrated the third lesson from the work of the Research and Experiments Department of the Ministry of Home Security in the application of scientific methods to problems of civil defence, such as the evaluation and development of types of shelter. Such methods have obvious application in building, and one of the first-fruits of such operational research has been the preparation of more than a score of monographs on the technique of building structures. Lord Portal's temporary post-war dwelling-house is

a further example of the practical application of research techniques and a precursor of greater things to come.

Such social research is part of a distinctive tradition of British social science, and Mr. Morrison expects a great extension of the techniques of exact quantitative study on society, social groups and their environment on one hand, and on the other the extension of social research into the qualitative field. In regard to the first, Mr. Morrison urged the importance of a study of social mobility—the rate and machinery of transfer from one social class or group in one society to another. He suggested that a study in Great Britain might show the universities acting to some extent as engines of social mobility, and to a greater extent as instruments of individual economic advancement Again, the problem of marriage and the question of actual geographic mobility requires investigation. In spite of their increasing importance in the age structure, we know little about the old as a social factor beyond their numbers We know little about the factors that shape the choice of occupation on leaving school, and how far this is affected by the occupation of their parents Besides this quantitative approach, we need as supplement a development of the case-history method—an intensive study of a number of individuals either by specially worked out methods of question and answer or by methods of word-association and picture-association. The development of personality and ability tests in the Services is a small beginning of this kind of approach, but the programme of extended social research would call for the creation of a new generation of social workers, and the training of large groups of students. Mr. Morrison is looking with keen anticipation to the extension in the social field of scientific techniques. Social scientists have a tremendous contribution to make to intelligent enlightened government, and Mr. Morrison believes that the full fruition of the social sciences, at present in a stage corresponding to the early phases of the physical sciences when they were uncertain about their explanations of cause, may not lie so far ahead of us.

PETROLEUM IN WAR AND PEACE

THE American Office of War Information has recently received a publication entitled "Developments and Trends in American Industries (Oil Mining and Refining, High Octane Gasoline)" which is in fact a collation of excerpts from trade magazine articles and other sources. It covers practically every activity of the American petroleum industry to-day, and gives some striking pointers as to the way in which war-time scientific discoveries will be harnessed to meet peace-time requirements.

Driven by the necessity for producing high-quality aviation fuels in enormous quantities, research workers, sponsored by the Petroleum Industry for War Council and the Aviation Gasoline Advisory Committee, have made startling progress. Until recently, 100-octane gasoline was regarded as an optimum fuel; but it has been superseded as a standard. There is a new 'Supergas' called triptane (paraffinic-trimethyl-butane), which is 50 per cent superior to *iso*-octane from which 100-octane gas is obtained; its anti-knock qualities are such that no commercial engine has been built which is capable of utilizing its full power. There is 'Dynafuel', which is also 50 per cent more powerful than standard 100-octane fuel, and there are no doubt other fuels of similar calibre which will become commercially available in peace-time. One is tempted to forget that the use of 100-octane spirit or super-gasoline for post-war motoring purposes implies the evolution of a 'super-car'. It is, in fact, unlikely that such fuels will be used in motor-cars for some long time to come, but it is interesting to note that petroleum chemists do envisage the production of a 70-mile-to-the-gallon motor spirit, not to mention 100,000-mile tyres, and 20,000-mile lubricating oils

Second only to aviation gasoline in war-time importance is the production of toluene for T.N.T. (trinitrotoluene). During the War of 1914–18, practically all the toluene used was produced from coal tar; but to-day, although more toluene is being manufactured in that way than ever before, the greater part is being supplied from petroleum oil refineries. Indeed, the capacity of hydroformer installations and attendant toluene extraction and purification plants has been so increased that it has been found possible to divert some of the toluene to 100-octane activities, after fulfilment of all requirements for explosives. Toluene in peace-time is a commercial solvent used in dyes and paint manufacture, but quantities required are not in any way proportionate to war-time demands Petroleum chemists foresee a sharp decline in toluene production after the War, but they equally foresee the possibility of converting toluene-manufacturing plants into machinery for making gasoline-blending agents.

Other war-time activities of the petroleum industry include the supply of a large part of the butadiene for the production of Buna-*S* type synthetic rubber; production of high-quality lubricating oils, hydraulic oils, and special types of lubricants capable of withstanding the bitter winter conditions of Greenland or alternatively the heat of the Sahara desert. Waxes more moisture-proof than tin, rust preventives, de-icing materials, fireproofing compositions for soldiers' tents, preservatives for mosquito nets, medicines, anæsthetics and a host of other war-time commodities are prepared from petroleum derivatives. In fact, refining has become so highly skilled compared with the old days when cuts were made to satisfy demand for one product only that its repercussions on post-war industry will be nothing short of revolutionary. To-day the petroleum chemist is master of a formidable number of highly specialized processes; for example, hydrogenation, dehydrogenation, hydroforming, reforming, alkylation, polymerization, isomerization, catalytic cracking, aromatization, cyclization, etc., and he literally tears apart (cracks) the petroleum molecule and reassembles it into the pattern he desires.

But it is not only the petroleum chemist who has forged ahead. Other branches of the industry have made parallel advances. In 1922 the deepest producing well in the world was in the Orange Field, Texas; it reached a depth of 5,490 ft. To-day a well in the Terrebone Parish Field of Louisiana has been drilled to, and is producing at, a depth of 13,475–90 ft. A new era in the art of exploration and discovery began with the use of the torsion balance and the seismograph. To-day gravimetric methods, electrical measurements, aerial mapping, geochemical and radiation techniques are all available to assist in the search for oil. Before the entry of the United States into the War, practically all the petroleum and petroleum products consumed in the

Atlantic Coast States were transported there by tanker. Now the "Big Inch" pipe-line is delivering more than 300,000 barrels of crude oil daily to refineries on the Atlantic seaboard, while the "Little Big Inch" delivers domestic fuel oil to the New York Harbour area. The "Big-Inch" main line is 1,254 miles long and the "Little Big-Inch" 1,475 miles.

SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH

THE annual report for 1943 of the South African Institute for Medical Research, Johannesburg, is a record of valuable war and other work. The work of the South African Medical Corps Establishment is directed from the Institute and is organized into eight sections. Their work includes the supply and administration of the seven large and fifteen small laboratories situated at military hospitals all over the Union and the two mobile laboratories based on the Institute; training of personnel in tropical medicine and laboratory work, which has been extended to naval medical officers; a military blood transfusion service, which has developed considerably; the supply of glucose saline and other fluids for intravenous use; a snake-catching unit, which caught an average of 50–75 cobras and puff-adders a month to provide venom for the manufacture of antivenene by the Institute (a larger and more permanent snake farm at Barberton is being planned and a valuable agreement has been made with the director of the Pasteur Institute, Brazzaville, French Equatorial Africa, for the supply of venoms from equatorial snakes); and a unit for catching gerbils for the use of the typhus-vaccine department, which catches about 1,000 gerbils a month. Assays of vitaminized foodstuffs have been done by the biochemical department for the Director of Supplies, the Red Cross Prisoner-of-War Parcels Section, and other authorities. The Institute is at present the only laboratory in South Africa able to undertake the assay of vitamins in foods. An important part of the war effort has been the continued production of typhus and yellow fever vaccines and other curative and protective sera for military use, and also the building up of a reserve of anti-gas-gangrene serum.

Research work has been done on pneumonia, meningitis, diphtheria, tuberculosis endotoxoid vaccine, tetanus, whooping cough, dysentery, plague, syphilis and other diseases. The enzyme purification and concentration of tetanus and diphtheria antitoxin, anti-gas-gangrene serum and polyvalent antivenene has made such progress that it is possible to plan large-scale manufacture of various antitoxins by this process. The susceptibility of various South African rodents to vole acid-fast mycobacterium of tuberculosis has been studied. Gerbils dying after a dose of 0·0001 mgm. had lesions with a histological appearance between those of tuberculosis and leprosy. Much work has been done on anti-typhus vaccines. It is claimed that experiments with the intradermal injection of typhoid vaccine have given satisfactory results; with this method less vaccine is required and there are no local or general reactions.

Considerable research work has been done on gas gangrene, one interesting result of which has been that, among eleven samples of sera of wild animals examined, the sera of two zebras, one inyala, four impala and four kudu contained *Cl. welchii* antitoxin.

It has been shown for the first time that epidemic typhus in the Transkei Territory is transmitted by lice. Murine typhus and tick-bite fever also occur in this territory. By serological tests, using pure Rickettsial suspensions, it has been found possible to differentiate between epidemic typhus, murine typhus and tickbite fever

Entomological work has included a study of the distribution of sandflies, species which transmit kala-azar have been found in Southern Rhodesia; this discovery is important because troops returning from areas in which kala-azar is endemic may bring home this disease. A survey of the fleas of the South African Union is also being made. Other subjects of study have been rat-mite dermatitis, due to *Liponyssus bacoti*, which is very common on rats in Johannesburg, intestinal myiasis due to Dipterous larvæ, the toxin found in the eggs of ticks which causes tick-paralysis and the fungal and nematode parasites of mosquito larvæ.

The Biochemical Department has done work on human nutrition, the nutrition of mosquito larvæ, carbohydrate metabolism and the mechanism of the sulphonamide methæmoglobinæmias.

The routine work of the Institute has again increased, although the military laboratories have taken over some of this. Further expansion of the Serum Production Department has been necessary. The large-scale serum-drying and freezing plant, the cost of which was borne by Sir Ernest Oppenheimer, has been completed and is in use. Very large quantities of vaccines have been produced. Typhoid endotoxin immunization in the Witwatersrand mines has reduced the annual incidence of typhoid since 1934 from 5·26 to 0·25 per 1,000 and the annual mortality from 1·18 to 0·05 per 1,000.

The reports of the branch laboratories at Port Elizabeth and Bloemfontein indicate that these also are vigorously developing the work of the parent Institute. G. LAPAGE.

AERIAL SYSTEMS FOR SHORT RADIO WAVES

A RECENT meeting of the Radio Section of the Institution of Electrical Engineers was devoted to the presentation of two papers dealing with the theory and experimental performance of special aerial array systems for short and ultra-short radio waves.

The first paper was by E. B. Moullin and was entitled "Theory and Performance of Corner Reflectors for Aerials". For wave-lengths of about one metre, a convenient arrangement comprises a pair of reflecting sheets inclined to one another to form a V, with a single aerial on the bisector. Dr. Moullin shows that the field from such a system can be calculated by image treatment and that an algebraic formula can be found when the angle of the V or corner reflector is a proper fraction of 180°. A numerical example given in the paper illustrates the convenience of the Fourier series for evaluating the radiation pattern when the aerial is sufficiently distant from the apex to make the main beam much sharper than a sinusoid, and concurrently to produce side-lobes.

This paper also describes an experimental investigation at a wave-length of about 1·25 m. of the radiation pattern produced by a half-wave-length aerial in a corner reflector with angles of 90°, 60° or 45°. Using sheets one and a half wave-lengths high and two wave-lengths wide, it was found that the radiation distribution is not appreciably modified if the apex of the reflector is amputated and the resulting hole closed by a flat sheet. Such a modified reflector affords a saving in space and also shows that the pattern is insensitive to the shape of the back of the reflector. Other experiments showed that the performance of this type of aerial system was inappreciably affected if the continuous reflecting sheets were replaced either by wire netting with a mesh about one fortieth of a wave-length inside, or by a comb of open rods about half a wave-length long.

In the course of the second paper, H. Page described some measurements of the performance of various horizontal dipole arrays operating on wave-lengths in the region of 15–20 metres as used at stations of the British Broadcasting Corporation. The main method of measurement adopted consisted in elevating a calibrated frame receiving aerial by means of a captive balloon; by varying the height and position of the balloon, the field strengths in different directions from the transmitting array were determined. In a second method, a frame aerial at ground-level was used; this gave only relative values of field strength and was used mainly to determine variations in the performance of the aerial array as the radio frequency in use was altered over a small band.

It was found that for an aerial array radiating over a flat site free from obstacles, there was good agreement between the theoretical and measured performance: the maximum field strength was of the order of 0·8–0·9 of the theoretical value. A sloping site or the existence of other nearby arrays may, however, cause appreciable departures from the theoretical characteristics. In particular, it was found that the loss of power in radiating through other aerial array systems may be as much as 40 per cent in some cases; and this loss is not necessarily associated with a resonant condition in the obstructing array.

It is concluded from this work that, in order to obtain the best efficiency in short-wave transmitting aerial arrays, these should be erected on as flat a site as possible and should be arranged to avoid radiation through other arrays; distant obstructions which intercept part of the main lobe of radiation should also be avoided.

'MINOR' ELEMENTS IN PLANT NUTRITION

OUR knowledge of the precise physiological functions of the so-called 'minor' elements in plant nutrition has not kept pace with the growing realization of their importance in agricultural and horticultural practice. A number of papers in the *Proceedings of the American Society of Horticultural Science* report the effects of certain minor elements on crop growth and behaviour. R. D. Dickey and M. Drossdoff (**42**, 74; 1943) show that 2 lb. of manganese sulphate per tree applied to the soil cured frenching of the leaves of the tung (*Aleurites fordii*), due to manganese deficiency. The same authors (**42**, 79; 1943) describe a 'cupping' of the terminal leaves of the tung, which are reduced in size and show an interveinal chlorosis and sometimes an apical and marginal browning This may be followed by leaf abscission and shoot die-back; the condition can be cured by applying copper sulphate (1/16 oz. per tree) to the soil. That the disease is due to copper deficiency and the ameliorative effects of the soil dressings of copper sulphate are not due to any indirect effect, is shown by the fact that spraying with copper sulphate is equally effective in curing the disease.

J. G. Maclean, W. C Sparks and A. M. Binkley (**44**, 362; 1944) in a manurial experiment with potatoes in an alkaline soil (pH 8·5) supplied the sulphates of iron, copper, zinc and manganese (25 lb. per acre) alone and in all possible combinations, in addition to adequate dressings of nitrogen, potash and phosphate. Besides noticeable effects on crop yields due generally to effects on tuber size rather than the number of tubers, all the treatments, except copper + iron + zinc, copper + zinc + manganese, iron + zinc, copper + manganese, and zinc +manganese, increased the thickness of the periderm of the tuber significantly. Whether or not a thickened periderm will reduce tuber damage during harvest and marketing remains to be seen, but the possibilities in this direction need no stressing. Effects of minor elements on skin colour of tuber of Red McLure potatoes are reported by W. C. Sparks (**44**, 369; 1944), who found that all combinations of minor elements tried increased tuber colour in the field, but the effect was greatest when iron, alone or in combination with copper or copper and manganese, was supplied.

Significant effects on carrots and turnips of application of borax, copper sulphate, manganese sulphate and zinc sulphate, to soils in which the crop showed no deficiency symptoms, are described by G. H. Harris (**43**, 219; 1943). The effect varied on the different soils (but copper always increased root yield) and yield, sugar content and keeping qualities of the roots were all affected by the treatment.

CYTOPLASM, VACUOLE AND CELL-WALL MAGNITUDES IN DIPLOID AND TETRAPLOID BARLEY

IN the larger cells of a 'gigas' or 'semi-gigas' allo-tetraploid, is the increase due to proportionate increases in the cytoplasm, the vacuoles and the cell-walls, or is it mainly due to an increase in one alone or in two of these? By careful analyses of the water, ash, sugar, 'protein', nitrogen, etc., contents of diploid and tetraploid plants of a single variety of barley, *Hordeum vulgare*, grown under constant nutrient conditions in photothermostats, I. Ekdahl (*Arkiv för Botanik* (Stockholm), **31**, No. 5, 1; 1944) is able to draw some interesting conclusions. Tetraploid leaves assimilate more slowly but have a higher proportion of their dry weight as sugar and ash than diploid leaves, but if this extra sugar and ash is deducted from the total dry weight, a 'residual' dry weight for 'protein', cell-wall, etc., is obtained which is the same in both tetraploid and diploid leaves. Calculated on the residual dry weight, fresh tetra-

ploid leaves contain about 30 per cent more water than the diploids, the roots, on the other hand, have approximately the same composition in tetraploids and diploids, whether calculated on fresh weight or residual dry weight Thus, "The difference between the leaf structures of tetraploid and diploid barley, apart from the difference in volume, appears to be that the tetraploid leaf cells contain comparatively more water, sugar and ash, while the amounts of cytoplasmic substances are proportionally the same. In the root cells it is mainly only the cell volume which is changed"

By correlating the analyses with measurements of the cell dimensions in a number of organs and tissues, it seems that when the cell volume increases as a result of doubling the number of chromosomes, in the leaf, the 'thickness' of the cytoplasmic layers and cell walls is uniformly increased but not to the same extent as the cell dimensions, that is, the cells have a larger proportion of their volume as vacuole. In the roots, however, the 'thickness' of the cytoplasmic layers and cell-walls increases to the same degree as the general cell dimensions.

FORTHCOMING EVENTS

Monday, January 22

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C.2), at 5 30 p m —Discussion on "Applications of Electricity to Water Supply" (to be opened by Mr J F Shipley)

Tuesday, January 23

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W 1), at 5 30 p m —Mr S R Raffety "Rural Water Supplies"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park London, S W 1), at 5 30 p m —Discussion on "Civil Aviation"

Tuesday, January 23—Wednesday, January 24

IRON AND STEEL INSTITUTE (joint meeting with the LINCOLNSHIRE IRON AND STEEL INSTITUTE) (in the Technical School, Cole Street, Scunthorpe), at 7 30 p m.—Mr G. D. Elliot: "Ironmaking at the Appleby-Frodingham Works of the United Steel Companies, Limited".

Wednesday, January 24

ROYAL SOCIETY OF ARTS (at John Adam Street Adelphi, London, W C 2), at 1 45 p m —Mr James B Firth "Forensic Science"

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP with the BRITISH RHEOLOGISTS' CLUB and the FARADAY SOCIETY) (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 2 30 p m.—Dr G W. Scott-Blair. "The Rheology of Plastics"

TELEVISION SOCIETY (joint meeting with the RADIO SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C.2), at 5.30 p.m —Mr Donald G Fink · "American Television Broadcasting Practice, 1927–1944"

BRITISH ASSOCIATION OF CHEMISTS (BIRMINGHAM SECTION) (in the Large Hall, Chamber of Commerce, New Street, Birmingham), at 6 30 p m —Discussion on "Social Security for Chemists"

Thursday, January 25

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p m.—Prof. J Hadamard. "Psychological and Personal Recollections of a Mathematician".

Friday, January 26

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p m —Mr. J. Foster Petree "Mechanical Engineering in the Shipyard" (Seventeenth Thomas Lowe Gray Lecture)

INSTITUTE OF FUEL (SCOTTISH SECTION) (at the Royal Technical College, Glasgow), at 5 45 p.m —Dr. J. M Ferguson "The Insulation of Open-Hearth Furnaces and Blast-Furnaces".

Saturday, January 27

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W 1), at 2 30 p.m.—Mr H. K. Bourne · "Electric Discharge Lamps for Photography".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

SENIOR EXECUTIVE ENGINEER by the Public Works Department, Trinidad—The Ministry of Labour and National Service, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway London, W C 2 (quoting Reference No E 1304 A) (January 24)

ENGINEER for the Public Works Department, Government of Trinidad—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No E 1299 A) (January 25)

HEAD OF THE DEPARTMENT OF SCIENCE of the South-East Essex Technical College and School of Art, Dagenham—The Chief Education Officer, County Offices, Chelmsford (January 27)

PLANT ENGINEER (must have general scientific educational background, degree in physics or mechanical engineering, some precision engineering experience essential) by a firm in Middlesex—The Ministry of Labour and National Service, Central (T and S) Register Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No C 2321 XA) (January 27)

CONTROLLER OF MATERIALS in the Directorate-General of Aircraft in India—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London W C 2 (quoting Reference No C 2430 A) (January 30)

ASSISTANT TO THE ADVISORY CHEMIST for the South Eastern Province under the scheme of the Ministry of Agriculture and Fisheries —The Acting Principal, South-Eastern Agricultural College, Wye, Ashford, Kent (January 30).

SENIOR RESEARCH CHEMIST with experience in manufacture of or research on petroleum products (Reference No F 2777.XA), a RESEARCH CHEMIST with chemical engineering qualifications (Reference No F 2778 XA), and a RESEARCH CHEMIST with laboratory experience in petroleum or heavy chemicals (Reference No F 2779 XA), in the Research and Development Department of a British Oil Company at its Refinery in N W England—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting the appropriate Reference No) (February 12)

ASSISTANT ENGINEERS (temporary) by the Kenya Government Public Works Department, for water supply schemes—The Ministry of Labour and National Service, Appointments Department A 3 (B), Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No E 1317 A) (February 12)

UNIVERSITY READERSHIP IN LOGIC AND SCIENTIFIC METHOD, tenable at the London School of Economics and Political Science—The Academic Registrar University of London, c/o Richmond College, Richmond, Surrey (February 26)

LECTURER IN VETERINARY PARASITOLOGY—The Registrar, The University, Liverpool (February 28)

DIRECTOR OF MUSEUMS—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2 (February 28)

CHAIR OF GEOGRAPHY, and the CHAIR OF GEOLOGY—The Registrar, The University, Sheffield (March 31)

UNIVERSITY READERSHIP IN ENTOMOLOGY, tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (July 31)

ASSISTANT (medical graduate) IN ANATOMY—The Secretary, The University, Aberdeen.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scheme for a Degree Course in Chemical Engineering Pp 28. (London Institution of Chemical Engineers) [101

Ministry of Labour and National Service Higher Appointments: Report of the Committee appointed by the Minister of Labour and National Service in July 1943 (Cmd 6576) Pp 62 (London: H M. Stationery Office.) 1*s* net [101

Other Countries

Bulletin of the Bingham Oceanographic Collection. Vol 9, Art 2: Studies on the Marine Resources of Southern New England, 1 An Analysis of the Fish Population of the Shore Zone By Herbert E Warfel and Daniel Merriman Pp 92 (New Haven, Conn Peabody Museum of Natural History, Yale University) 1 50 dollars. [2812

Annual Report of the Imperial Council of Agricultural Research for 1943–44 Pp ii+44 (Delhi Manager of Publications) 2 rupees, 3*s*. [2812

Republica Argentina. Ministerio de Agricultura, Direccion de Meteorologia, Geofisica e Hidrologia Serie E, No 1 El Tercer Centenario del Barometro Pp. 12. (Buenos Aires Ministerio de Agricultura) [2812

Indian Forest Leaflet No 65. Conditioning Chamber for Plywood. By M. A. Rehman. Pp. ii+3 (Dehra Dun. Forest Research Institute) 6 annas, 7*d*. [2812

Food is Where you Find It · a Guide to Emergency Foods of the Western Pacific. By Lucy M. Cranwell, Josiah E Green and A W B Powell. Pp 72+4 (Auckland: Auckland Institute and Museum.) [41

Seventeenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1943 Pp 76. (Canberra. Commonwealth Government Printer) 3*s*. 4*d*. [41

Papers of the Michigan Academy of Science, Arts and Letters Vol. 29 (1943). Pp. xiii+606. (Ann Arbor, Mich. University of Michigan Press, London · Oxford University Press) 5 dollars, 28*s* net. [51

New Zealand: State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1944. Pp. 38 (Wellington: Government Printer) 1*s*. [51

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SCIENCE AND HUMANITY

ANY doubts as to the value of the Conference on "The Place of Science and Industry", arranged by the British Association in January 12 and 13, should have been removed by Lord Woolton's well-deserved tribute to the way in which the educational work of the Association in the field of nutrition, carried out over the ten years following Sir F. Gowland Hopkins' presidential address at Leicester in 1933, had prepared the public mind for the food policy which averted the threat of definite food shortage in Britain soon after Lord Woolton took office in April 1940. People had come to realize that nutrition, far from being a fad, was the plainest of common sense. A nutrition policy which aimed at distributing food on the basis of its nutritional value, not its capacity to satisfy appetite, so that the vulnerable classes—mothers, expectant mothers, infants and children and heavy workers—should have full protection, and the rest of the population should have a physiologically adequate diet, had met with the approval and support of the public. Further, such a policy is in a fair way to become a permanent part of the food policy of Britain. The immense benefit to the nation's health and the actual raising of the pre-war standard even under stress of war have already been generally recognized, and if other speakers besides Lord Woolton dwelt on the point, it was rather to stress the folly of lightly abandoning such a solid advance, and to indicate the immensely greater possibilities which the further extension of scientific research in this and in related fields and its application in practice and policy hold for the future.

What is true in this important field of food and nutrition is true in other fields. The effective application of science to social and industrial affairs involves the understanding and support of the general public. In discussing scientific and industrial research in these columns last autumn (cf. *Nature*, 154, 407; 1944), it was pointed out that the expansion of such research to the scale required involves a clear and widespread public understanding of its purposes and implications. It is as a contribution to the task of public education that the Conference is important, and both Sir Richard Gregory and Sir Harold Hartley were at pains to stress this point. The Conference was not just another in the long series of debates, discussions and reports on this subject in the last two or three years: it was a step to further public education, on which the expansion of research depends.

Even such a brief account of its proceedings as is printed in the present issue of *Nature* (p. 96) gives some idea of the justice with which it can be claimed that the Conference has helped to prepare the public mind for what is involved in the expansion of scientific and industrial research to the scale imperative for an adequate attack on post-war problems. When the full report of the Conference is published, it will provide scientific workers generally with much material to assist in the task of educating the public. The Association can rarely have assembled an array of speakers so imaginatively alive to the issues, so able in exposition and in interpretation and, it may

be remarked, so clear in delivery. Even the more commonplace papers showed no lack of honest workmanship, and should be equally useful in the task of further public education.

The papers which touched on food and nutrition illustrated two further characteristics of the Conference: the dynamic character of the relations between science and industry; and the strong emphasis on the social factors, both in the prosecution of research and in the application of its results. The continued reaction of science on industry and of industry on science, the way in which industry stimulates science as well as science industry, or in which one industry stimulates another, was apparent in one field after another. Whereas Dr. W. T. Astbury linked the textile industries with the advance of biology and the plastics industry, Prof. J. M Mackintosh summoned not merely the biologist and the chemist but also the mechanical expert and the plastics industry to the help of the surgeon.

The Conference thus provided a powerful demonstration that we cannot wisely tolerate stagnation in any field of industry, and that we must seek to promote advance along the whole industrial and scientific front so as to maintain a proper balance. But there must also be a fuller measure of co-operation and a further attempt to integrate knowledge both in the scientific and technical field. Here again it was urged that we should learn the lessons of the war years and apply them to the tasks of peace, and Sir Lawrence Bragg uttered a wise warning against mistaking the means for the end. The material achievements which science makes possible—rapid communication and travel, power and command over materials—are making the world a higher type of organism with a more complex nervous system and greater division of function. But the material and technical achievements must be seen against the cultural and moral background, so that we can diffuse that wide understanding of science which is the best safeguard against its misuse, and the surest inspiration to the service of society.

That idea, never entirely absent, came most insistently to the front in the final session. The importance of the social motive as a stimulus to research explicitly stressed by Mr. E. Carter was implicit in all the other papers, though in Sir Lawrence Bragg's the emphasis was rather on its value in attracting to industry men of the highest calibre. There was general agreement as to the shortage of men of the highest capacity for the main fields of research to be pursued, and while there was some uncertainty as to how far Sir Lawrence Bragg was right in this particular contention, the changed outlook, the emphasis on serving the needs of the consumer rather than on the profit motive, and the recent developments of economic science, all trend in the right direction of increasing the attractiveness of a scientific career in industry, on the importance of which, from different points of view, so much stress was laid throughout the Conference. With all the emphasis on industrial efficiency, this was viewed against the right background and interpreted in no narrow financial or mechanical sense, but as covering the social efficiency also—the extent to which an industry can serve the needs both of the workers it employs and of the community, industrial or social, the wants of which it is its prime purpose to supply.

Here as elsewhere there was vision and imagination. The Conference was undoubtedly a step to supply that publicity for which such reports as that of the London Chamber of Commerce last year so insistently called—the stimulation of public interest in scientific work and the interpretation to the public of the results of that work in industry. Certainly it demonstrated that we have the capacity to combine science with practice in industrial development, and that increased contacts will ensure the advancement of both. But more than this, the Conference was of importance in the field of public relations. The dynamic picture of the relations between science and industry unfolded in its sessions, the imaginative glimpse of the possibilities before us in the post-war world if we harness aright knowledge and power, cannot but make for closer understanding between the parties concerned, whether management and labour, the industrialist, the Government administrator, the scientific worker in the university or in industry, the producer and the consumer. Above all, it is a great challenge to the scientific worker himself, in whatever branch of science, pure or applied, he may be engaged, to explore more fully, more patiently, more resolutely and imaginatively those many fields where knowledge is still lacking; not least where new knowledge and creative thought may contribute most swiftly and significantly to the evolution of the new forms of organization which may be required to serve the needs of to-morrow, and to place freely and fully at the disposal of all the rich resources and wide powers which science is giving us to command, while safeguarding the freedom and culture which are our most precious inheritance.

HUMAN SEX HORMONES

The Hormones in Human Reproduction

By George W. Corner. Pp. xix+265+24 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1942.) 18*s*. 6*d*. net.

BIOLOGY teachers are soon going to be confronted with the problem of bringing up to date text-books on a number of subjects, particularly those which have not previously been well presented to the student. Curiously enough, there are few works which provide an authoritative introductory account of the factors underlying human reproductive processes. This is partly because the interval between the War of 1914–18 and the present War was one of very active research, in which most people with first-hand knowledge of the subject were too absorbed in experimental work to turn to the task of summarizing the progress which research was making. Prof. Corner's book on the hormones in human reproduction is therefore most timely, for it is at once a concise and a comprehensive exposition of the subject, given by one of the foremost contributors to knowledge in this field of physiology. The book was published in the United States in 1942, but, as relatively little new has since emerged in this line of research, it provides as up-to-date a general treatment of the subject as

could now be desired, and in so doing fills a very real gap.

The book is, however, much more than a useful text-book. It is a fascinating story which will also prove of interest and value to the lay reader. Here again it answers a long-felt need for a simple but accurate outline of the processes of reproduction, presented in a form which is both intelligible and attractive to the non-scientific public. This in fact, as Prof. Corner tells us in his introduction, was his main purpose in writing the volume, which was built up round the Vanuxem Lectures he gave at Princeton in February 1942—lectures intended not for specialists but for a mixed university audience. His aim has been brilliantly realized, for the book is all that can be asked of a general presentation of a complicated subject. It is brief; it eliminates unessentials; it carries the reader gradually into each topic by showing what the problems were that had to be solved at each step; and, over and above all, its style is not that of a scientific treatise but of a literary work. The romance of discovery is colourfully illustrated, particularly in the chapter which deals with the progestational hormone, a field of inquiry which will always be associated with Corner's name. It also indicates the established limit of knowledge by showing where present researches promise to break new ground.

The volume opens with a general statement about sexual and asexual reproduction in the animal world. The second chapter considers the human egg, and the organs that make and care for it. The third deals with the periodicity of ovarian activity, and discusses variations in the sexual cycle in mammals. The chapter which follows is a fascinating account of the discovery of the œstrogenic hormones, and of their action. Chapter 5 deals with the hormone of the corpus luteum, which is responsible for the uterine changes that permit the implantation of the fertilized ovum. In this chapter Corner gives a most lively résumé of the part he played in the story, and of the difficulties which had to be overcome. However disheartening it may have been at the time, one can now appreciate the lighter side of the episode he relates—how he was racing up the steps of his laboratory at Rochester, carrying a glass syringe which contained the world's entire supply of crude progesterone, when he stumbled and fell, and lost it all. The chapter which follows deals with the endocrine control of the menstrual cycle, and gives a very balanced statement of this difficult question. Next follows a chapter on endocrine arithmetic, which presents some novel calculations about the amount of sex hormones produced daily in the body; then a chapter on the hormones of pregnancy, and finally one on male hormones. The brevity of Corner's account of the male side of reproduction is perhaps the only feature which one can regret in the book. Each chapter considers the clinical applications of the sex hormones, and each is excellently illustrated.

While, as Prof. Corner tells us, the volume was written primarily for the layman, it is certain that it will also be widely used by the student as an introduction to a growing branch of knowledge. Quite apart from the function which it is likely to serve in this way, it will undoubtedly, because of its delightful presentation, attract to the subject new research workers, who will discover from it at least as many problems to engage their attention as those which he has so admirably elucidated.

S. ZUCKERMAN.

SEX EDUCATION AND GUIDANCE

Sex Education

A Guide for Parents, Teachers and Youth Leaders. By Cyril Bibby. Pp. xi+291. (London: Macmillan and Co., Ltd., 1944.) 7s. 6d. net.

HOW thorny the question of sex is to the adult mind is aptly symbolized by the myth of the gooseberry bush; and the consequences of the conspiracy of silence are seen by doctor and psychiatrist. It is, however, a truism of practice that none but serious cases come for treatment, and much daily friction and maladjustment arising from unresolved sex conflicts does not reach the consulting room. Few indeed are the adults who cannot recall from their own adolescence periods of intense psychic pain which greater enlightenment might have spared them; more fail to achieve harmony in marriage and that liberation of energy which comes of an unclouded mind, not because they were born abnormal, or because adjustment to modern conditions is impossible, but because, at critical periods of psychic development, they lacked the right emotional attitude towards manifestations of their own sexuality.

As yet, we have not had a generation of parents in whose outlook sex problems and interests take as natural and unexaggerated a place as questions of dietetics or physical exercise. We cannot, therefore, say that a sound sex education will be a panacea for the mental ills of society. Indeed, experience with the neuroses of the War of 1914–18 has shown that conflict between *any* innate instinctive impulse and the environment may bring about neurotic dysfunction. With confidence, however, we can assert that a system of education which strips sex of the shameful glamour which decorates walls with obscene epigraphy, and presents it as something natural and healthy like breathing, eating and sleeping, will diminish tension and conflict and contribute to happiness and efficiency. That this is very largely now an accepted thesis among educationists and even among the majority of laymen represents a broad advance of great moral and ethical significance.

It remains for the educationist to meet the practical difficulties of applying the principle. Mr. Bibby's book is an attempt to do this in a comprehensive way. Recognizing that sexuality is coterminous with life itself and pervasive of all aspects of the personality, he does not rest content with mere training. His suggestions cover the whole education of the child, the youth, the adolescent and the young adult. For him, sex education is a preparation for life itself, not a matter only for the biology lesson or an allusive discussion of the pollination of flowers. A beginning should be made in the nursery, not alone on the basis of imparted facts—though these are important—but in the creation, by parental precept and attitude, of a right outlook. The school-child should already have received an emotional and factual education on this topic on which the teacher can build with confidence his more specific training. Literature, religion, geography, history and even mathematics—all subjects of the curriculum—can then be laid under contribution in the building up of a generation emancipated from dark mystery and happy in a deeply ingrained habit of control.

This, Mr. Bibby recognizes, is an ideal, though not perhaps too remote. Few, as yet, have the necessary knowledge or the fundamentally sound emotional attitude necessary for the instruction of their children in the earliest stages of life. At present, therefore,

the task devolves largely upon the teacher and youth club leader. His book is a guide for bridging the transition period between the present and a future of fully enlightened parents. How practical it is can be seen by the appendixes, which contain specimen lecture material, suggestions for concrete activities and a tentative but comprehensive scheme for sex education throughout the whole early period to full maturity and parenthood. The body of the book contains sound advice, documented by references to research, and illuminated with well-chosen examples of questions put by children, adolescents and adults Particularly valuable to the parent is Chapter 3, which swiftly and effectively deals with the major problems of sex as they arise in the home and which may well clear away cobwebs in the adult mind. The discussion which follows, of the place of sex education in the school curriculum and the kind of teaching appropriate to the various stages of development, is based upon unimpeachable psychological and educational principles. Chapter 6, which gives a brief outline of the changes, intellectual, emotional and physical, of adolescence will have special significance for youth leaders and all who have to do with boys and girls in that most critical of all phases.

The book is comprehensive in scope and framed to meet the needs of the intelligent but not specially instructed reader. This, however, does not mean that it is either superficial or elementary. Indeed, it might well be recommended as a text-book on the educational aspects of sexology. The bibliography will introduce the interested reader to literature of more specialized kinds, and the author's brief comments on the books he recommends will be found of the greatest value. It is a pity that an index is not provided, for, although the author seeks to justify the omission in his introduction with the plea that his subject must not be viewed piecemeal, this reviewer feels that a speedy reference to particular passages would be of value to the busy teacher, the more so since many topics are dealt with in their several aspects in different parts of the book. An index would serve to bring together all that the writer has to say on any important aspect of his subject. A further point concerns the vexed question of acknowledging the source of quotations and references. Mr. Bibby has obviously drawn extensively upon the work of others: lengthy footnotes are out of place in a book like this; but it would be helpful to the reader who wishes to pursue the subject, if sources and page references were given.

These, however, are small criticisms of a book so sane and moderate in its outlook, so much needed at the present time, and so calculated to further both the general cause of education and the more specific purpose of spreading enlightenment and banishing prejudice. W. D. W.

THE SPIDER'S WEB

La toile géométrique des araignées

Par André Tilquin. Pp. 536+8 plates. (Paris: Les Presses universitaires de France, 1942.) 150 francs.

In this work Dr. A. Tilquin sets out the results of six years research on the making of the familiar orb-webs spun by spiders of the family Argiopidæ, and it may be said at once that the book is well worth the attention of all, whether arachnologists or not, who are interested in the study of instinctive behaviour.

The author begins by clearing away any psychical factors. He finds it impossible to detect any evidence of mental relationship between a man and a spider of the kind which is common between a man and his dog. Whereas to the dog his master seems to appear as an individual, to the spider a man represents no more than a source of shade or warmth, so that in all its life the spider never shows more recognition of man than is expressed in an inhibition of the reflex dropping from its web at his approach. Clearly, therefore, a mechanistic description of web-making is to be expected throughout

The difficulty of getting Argiopidæ to make normal webs in captivity has been overcome by providing each spider with an isolated wooden framework, to which the web is fixed. An Argiopid spider, it is clear, must have sufficient space for its operations, which cannot be reduced to a smaller scale, and Dr. Tilquin has devoted two rooms in his house to their accommodation. More than a dozen species have been kept under observation, but most of the work has been done with *Argiope brünnichi.*

Two chapters are occupied by a description of the web, an accurate analysis of its constituent parts and their variation among different species; for the author observes that a minute study of web-structure, made independently of the actions of the spinner, is the best introduction to the study of these activities themselves. It clarifies the problems set and points the way to their solution.

Chapter 3 is chiefly a consideration of experiments on the influence of light and gravity in determining the direction of the *fil suspenseur*, or the strong cable from which the web hangs and which forms the upper limit of the whole field of operations. The next two chapters deal with the construction and spacing of the radii. A new conception is introduced here, namely, that solid and stable points of support exert an attraction for the spider, whereas unsteady flexible ones are less attractive or even repellent. This determines the distance of the hub of the web from the *fil suspenseur*, and so affects the area and symmetry of the circular portion. It also influences the angles between the radii, so that often these angles have different values above and below an approximately horizontal middle line. These chapters expound Dr. Tilquin's concept of the web as a *champ dynamique*, an area in which forces of attraction and repulsion are at play, and the spider is moved into equilibrium with their resultants.

The next three chapters apply this hypothesis or concept to the laying down of the temporary spiral, its removal and replacement by the viscid spiral. The effects of age, sex, moulting, mating and egg-laying are included, and form one of the most original portions of the monograph. A chapter follows on the special features peculiar to the webs of a single genus or species, and the tenth chapter is a general summary. It is characteristic of Dr. Tilquin's methods that he here introduces the term *sériciphilie* to describe a spider's apparent preference for touching silk rather than anything else: for example, the spider's 'foot', placed on the thread which leads from the hub of the web to its hiding-place, is exhibiting *sériciphilie*, rather than awaiting the occurrence of vibrations.

Dr. Tilquin, writing of these and other matters with an almost excessive attention to detail, has made an advance on the researches of Peters and of Wiehle, both of whose theories he criticizes; and he has made a notable contribution to our understanding of an object which is unique among the products of animal industry. T. H. SAVORY.

Building Illustrated

Being an Introduction to Standard Building Methods. By W. H Smith. Pp viii+112 (London: E. and F. N. Spon, Ltd., 1944.) 16s 6d.

THE value of the attractive paper cover on this book has been made useless by the numerous mistakes which appear on it For example, and here I quote from a copy of by-laws with respect to new streets and buildings: "Each external wall shall be provided with an effective damp proof course at a height of not less than six inches above the surface of the adjoining ground' The damp proof course shown on the paper cover is just over three inches above the ground-level.

The orthographic drawings have not been made in accordance with the British Standard Specification Drawing Office Practice. To give examples, the sections of Figs 29, 82 and 86 want turning over so as to be in correct projection, and plain lines should have been used for all measurement lines instead of broken lines as shown throughout the book.

Now a word or two about windows. The pulley stile in detail *A*, Fig 83, wants turning over so that a proper tongued and grooved joint is made

The freakish *S* which pervades the drawings should be avoided by students when printing the titles, as this is more often mistaken for an *F*.

There are two particularly good chapters; one is on drainage and the other on defects found in buildings. A. S. EMERY.

An Introduction to Philosophy

By W. A. Sinclair. Pp. 152 (London, New York and Toronto. Oxford University Press, 1944.) 5s. net.

THIS clear and well-reasoned introduction starts from the classical problem of modern philosophical thought—sense perception and the knowledge we take to be based upon it. For the scientifically trained reader this is probably the best approach, though not necessarily for other readers. By his method of treating the subject Mr. Sinclair challenges comparison with Russell's well-known "Problems of Philosophy" and survives the test very well. He scarcely has the lightness of touch of his predecessor, but he is rather more systematic and is better at indicating further possibilities and other inquiries. The footnote references to important thinkers are well done. The advice for further reading is refreshingly unconventional, but not well balanced: and what is said about Plato and Greek philosophy is definitely misleading A. D. R.

Proceedings of a Conference on Problems in the Utilisation of Small Coals

Held at the Institution of Civil Engineers, November 10th and 11th, 1943 Pp. 294. (London: British Coal Utilisation Research Association, 1944.)

IT is inevitable that incombustible matter accompanies coal arriving at the pithead and in varying degrees of association, depending on the quality of the seam. From this point follows a series of cleaning processes—dry and wet—which in general aim at the removal of dirt and fine coal Water is usually necessary, and as a consequence the colliery must dispose of the unwanted residue of the cleaning process which contains an undesirable proportion of water. This residue, commonly known as 'slurry', consists of coal which contains too much incombustible matter, too much water and at the same time is too fine in size to have commercial value. This combination of physical conditions imposes such difficulties that remedial measures to convert 'slurry' into salable fuel are in normal times unremunerative. but this is only a relative term, for the quantity of this waste of potential value is enormous—many millions of tons—which in times of scarcity is actually used It may be that the days when this fuel can be so lightly discarded as hitherto have already passed for ever. It must be recognized that the mining industry has in the past given much attention to the problem, as will be evident from the present report on the conference on the utilization of small coals, at which twenty-eight papers were presented. These give a measure of work done, while a visit to the surface workings of a colliery will reveal the scope of the task of disposing of the wet, dirty fine coal which is produced. There is another if somewhat different problem in the disposal of fine coke

H. J. HODSMAN.

A Handlist of News Pamphlets, 1590–1610

By Dr. D. C. Collins. Pp. xx+129. (London. South-West Essex Technical College, Walthamstow. 1943.) 10s. 6d.

THIS admirably produced little volume is in two parts: first, a handlist of news pamphlets printed between 1590 and 1610 and still extant; and secondly, a list of such pamphlets printed between 1590 and 1610 and entered in the Stationers' Register, but not now extant. The first list is annotated, the contents being indicated where the title is insufficient, and the comments show the significance of the item. The list is arranged chronologically, and within each year according to the date of entry in the Stationers' Register. Surviving pamphlets not entered in the Register follow the last entered copy surviving for each year. Where more than one copy of the pamphlet survives, the British Museum copy has normally been used. Other copies used are indicated by a reference letter; but the names of libraries possessing a single unique copy are given in full. If the copy for the transcript is one not recorded in the Short Title Catalogue, the press mark of the library is given. Both the Short Title Catalogue number and the date of entry of the pamphlet in the Stationers' Register and the high standard of bibliographical detail should make the list the more valuable and welcome for research into the collection and dissemination of news during the period covered. Its value and purpose in this respect are concisely explained in Dr. Collins' excellent introduction.

Get to Know Yourself

A Series of Psychological Tests. By Joseph Ralph. Pp. iv+89. (London: Chaterson, Ltd, n.d.) 3s. 6d. net.

APART from the suggestion in the title that more self-knowledge is desirable and a few sensible remarks here and there, this book has little to commend it. The author sets out a series of so-called self-rating 'tests' of nineteen 'dispositions'. Numerical weights, determined presumably by the author's inner consciousness, are attached to each test item. Norms suggested have an equally subjective quality. The term 'test' is certainly a misnomer for a set of overlapping and equivocal questions unstandardized or scaled in any way. The alleged 'dispositions' are nothing more than a mixed series of popular catch-phrases. No substantiation is given of the claims on behalf of the tests in the prefatory note. J. C.

THE PLACE OF SCIENCE IN INDUSTRY

As was stressed by Sir Richard Gregory in his introductory address, and again by Sir Harold Hartley in summing up at the final session, the two-day conference on "The Place of Science in Industry", arranged by the Division for the Social and International Relations of Science of the British Association on January 12 and 13, and held at the Royal Institution, was no mere repetition of discussions on scientific and industrial research, or the relations of science and industry to be found in numerous recent reports. It could not be claimed that fresh ideas in regard to the strategy and tactics of research or its organization were ventilated at the Conference, though some of the war-time achievements of science were disclosed for the first time to a wider circle. The subject was viewed essentially in its social setting, and the Conference was a definite attempt to further that task of public education upon which the adequate support of research depends. Unless there is general understanding of the achievements and the possibilities of scientific research, we cannot expect that there will be forthcoming the public support, either of finance or of men, on which the expansion of our scientific effort to meet the post-war demands and opportunities ultimately depends.

As Sir Harold Hartley pointed out, the Conference had two main objects: to give the public a detailed idea of the contributions of science in industry, and to give a clearer view of what should be our strategy and tactics in this field. Its organization was thus in harmony with the educational work of the British Association in the field of nutrition to which, at the final session, Lord Woolton paid such a generous and emphatic tribute. If a tribute no less emphatic and generous should be paid to the Association by some future Minister of Production for its work in this field in promoting general interest and understanding of the place and application of science in industry, it may well be for the balanced and lucid presentation of the subject which characterized the recent Conference.

Sir Richard Gregory dealt with some of the popular misconceptions of the past and referred to the impossibility of a sharp separation between research workers in pure and in applied science, or again of separating scientific workers from other citizens in their social duties and responsibilities. He urged that there must be a two-way traffic between science and industry if we are to be in the van of progressive life and service. Advances on this united front would raise standards of living and strengthen the social structure if they are correlated with humanistic national policy. Public opinion would not now tolerate the deplorable social effects of the introduction of new powers and processes of a century or more ago.

Referring even more emphatically than Sir Richard Gregory to the lag between scientific knowledge and social wisdom, Mr. Ernest Bevin, who presided over the first session, on "What Industry Owes to Science", commented on the greater receptivity of industry to scientific ideas in war-time than in time of peace. The time lag, he believes, is due partly to faults in the management or directorate in industry, and partly to traditions of the past. He urged closer study of the problem of how best to bring the benefits of scientific discovery into the lives of the people so that they can be enjoyed by the masses as quickly as possible and at a price within their reach. The people should, as it were, have a vested interest in a scientific discovery.

Following on Mr. Bevin's plea for social and economic research—and it was notable that the Conference was never allowed to forget such aspects—the session considered some of the industrial achievements of science in a way which should win the support of any trade unionists who tend to look askance at science. Lord Brabazon's dry humour played delicately over the achievements of aviation, emphasizing the immense potentialities opened up by jet propulsion with its gas engine, revolutionizing aeroplane design and speed, with possibilities as power units in other fields He referred to the important part which the universities must take in such fields, the necessity of full freedom for the fundamental research worker, with no dictation as to the detailed direction of his work Sir Robert Watson-Watt followed with a paper on telecommunications, in which once again the repercussion on, and stimulation of, other industries by research in a particular industry was stressed. Distinguishing between the internal science and external science with reference to an industry, the former being scientific effort oriented towards the direct solution within the parent technique of the industry of problems peculiar to the industry, Sir Robert said that the telecommunications industry has been exceptional, and exceptionally fortunate, in its utilization of external science. He instanced the demands it has made on the metallurgist for metals, on the inorganic chemist for dielectrics, basic materials and coatings, and glasses which 'wet' the metals used in the vacuum tubes, on the organic chemist for dielectrics for cables, on the crystallographer, the electron physicists, on those expert in classical optics, acoustics, geophysics and solar physics.

Much the same, if less extensive, stimulating interplay between industry and the sciences and between industries was revealed in Dr. W. T. Astbury's paper on synthetic fibres. Dr. Astbury pointed first to the close relations between textiles and biology, and then to their relations with the plastics industry, and to the part played in recent developments by such a tool as X-rays. The reasoned, scientific development of regenerated protein fibres is a direct consequence of X-ray studies carried out in a university. Again, such synthetic fibres are really supplementary to natural fibres and not just substitutes; they increase textile potentialities, and at the present rate of progress and in a sane economic world there is no knowing to what heights science may lead the textile industries. Dr. Astbury strikingly emphasized the indivisibility of science, pointing out that the study of wool and the study of muscle are not easily separated, and Prof. J. D. Bernal, in summing up, said that science and industry are two aspects of one principle: we must find the proper relation between the organization of science and industry, always remembering that it should be a two-way traffic. Whereas in the older industries the process may be mainly one of infiltration of science, in the newer industries the discussions indicated that the most conspicuous feature might be the stimulation of science by industry.

Opening the afternoon session on "Fundamental Research in Relation to Industry", Lord McGowan, who presided, suggested that we should consider as fundamental any research which is primarily directed to increasing our understanding of the causes of phenomena and of the principles and generalizations which make up the so-called 'laws' of Nature. Com-

menting on the development of our knowledge of plant design, he suggested that what is commonly termed the 'safety factor' to allow a sufficient margin of size would be more aptly described as the 'ignorance factor'. Research in the chemical industry can be described as of four types: that directed to maintain and improve the quality of products and economical working; chemical engineering research, that into problems of industries served by chemical industry, such as agriculture; and speculative research, such as that in the high-pressure field, of which polythene has been the outcome. On this Lord McGowan commented that it is difficult to ensure the continuous prosecution of fundamental research in a laboratory where interesting and exciting industrial developments are taking place The bulk of the fundamental research should be carried on in university laboratories, though some would be carried out in Government laboratories, and Lord McGowan said that Imperial Chemical Industries Ltd. has decided to establish a special laboratory for fundamental research, administratively and geographically separated from works laboratories.

Lord McGowan was followed by a trio of brilliant papers which should effectively dispose of the view once entertained at British Association meetings that engineers have the monopoly of lucid exposition and clear delivery. Prof. P. M. S. Blackett, dealing with physics, urged that research should be directed to cheapening the production of good articles and not simply towards increasing the number of fancy articles, and referred to unfavourable factors in our economic system which require attention. He urged that close relation between pure and applied research is essential and condemned the snobbery which sometimes hinders such contacts. More generous support for fundamental research is required, and he pleaded for more corporate action by scientific bodies such as the Royal Society and professional bodies in reviewing the country's scientific resources, their disposition, and the planning of policy. To do this, staff will be essential and a watch should be kept over the effect of chance discoveries. Our main task is to ensure, first, the application of science in raising the standard of living; the prosecution of science as a cultural or intellectual interest will follow. If Prof. Blackett's observations were general, Prof. E. C. Dodds kept strictly within the field of biochemistry, using the discoveries of penicillin, of insulin and of the synthetic œstrogens to illustrate the immense potentialities of biochemistry for human life, especially in the Middle and Far East, where the repercussions on population problems may be profound. All these discoveries arose in academic laboratories, and the first need is to encourage fundamental research and provide the investigator with every facility to experiment merely for the sake of experimenting.

Dr. C. D. Darlington, in discussing the unity and power of biology, gave a no less fascinating picture of the implications of biology in the field of plant and animal breeding, of the control of diseases of crops, and of such human scourges as cancer. The teaching of biology, he urged, is thirty years out of date, and that will delay the fruition of the unity and power which he described. From what we know of different modes of activity of proteins, common fundamental principles are emerging, which will provide an intellectual and a material power which will make life very different for us all. Dr. D. P. Riley, who followed, in spite of the fact, which he duly noted, that the speakers at the Conference included five eminent in X-ray work, made the mistake of attempting to cover too wide a field in the time, and his enumeration of the many fields of application of X-rays in science and industry was too ill prepared to leave him the opportunity to develop adequately his remarks about the training courses in X-ray work at Cambridge to ameliorate the shortage of X-ray workers, or on the importance of freedom of publication of scientific research both as a stimulus to research and an incentive to the investigator.

The session on the morning of January 13, over which Sir John Greenly presided, was devoted to industrial research and development, and brought some more impressive evidence of British technical achievements and the impact not only of science on industry, but also of one industry on another. Sir John Greenly, confining himself to general observations, reaffirmed his own conviction that science has contributed and will continue to contribute immeasurably to successful industrial enterprise. Quoting from Marcus Aurelius, he urged that to investigate systematically and truly all that came under our observation is exactly what we expect of science in its application to industry. Besides the contribution of new ideas and prospects from fundamental research leading to new inventions, there is, scarcely less important, the continuous help given to the normal conduct of a business by indicating improved methods of production and suggesting the use of new materials. He cited welding as a particularly good illustration of the way in which science has helped to make an industry more efficient and, by providing a new and better technique, assisted in solving the problems of export and full employment. Finally, he stressed the importance of full co-operation and team-work on the part of all concerned, and above all of giving the scientific worker the fullest opportunities in order to enable him to continue to be the pathfinder of industry.

Dr. C. Sykes followed with a review of the general field of metallurgy, in which he pointed out that there is no hard and fast line between research and development. Dr. Sykes emphasized the cost of development work and the dependence of the rate of development on the degree of confidence it establishes between suppliers and users With regard to post-war development, he foresees four types of problems and needs: the proper allocation of the available technical personnel; the adequate development of schools for research at the universities; the encouragement of enterprise, in which connexion he welcomed the Chancellor of the Exchequer's recent concessions with regard to obsolescence; and the furthering of collaboration between industries. It was natural enough that Dr. S. G. Hooker's account of the development of the Merlin engine and of what those developments have meant in extending the carrying power, climbing power, speed and general performance of aircraft in service with the Royal Air Force should have attracted most attention at this session of the Conference. His paper provided a striking illustration of technical and scientific development stimulated by the War; but Mr. W. C. Devereux's paper on research and development applied to light alloys was more instructive with regard to the main purpose of the session. Mr. Devereux gave a most striking picture of the way in which scientific advances, such as Dr. W. Hume-Rothery's brilliant work in metallurgical physics at Oxford, and new techniques such as X-ray diffraction, are opening up new possibilities in this field. Like Lord McGowan, he referred to the twin function of

the universities in advancing knowledge of science and in providing industry with men qualified to interpret this new knowledge. Industry also must play its part by making scientific posts sufficiently attractive to ensure a steady stream of the right type of men through the universities He also suggested that the universities might take stock of the position arising out of the demand for scientific men fully qualified for the higher posts in research management and administration, for which there is at present an undoubted lack of suitable men. Mr. Devereux commented on the way in which the volume of routine testing is increased by lack of fundamental knowledge of the properties of materials; and describing the development work at Light Alloys Ltd., said that in addition to a Process Development Department dealing with the development of new processes and improvement of old processes within the scope of their normal activities, there is an Engineering Development Department concerned with the development of new ideas and the engineering uses of the products manufactured. Dr. J. C. Swallow, in the course of a brilliant short paper on plastics, contrived to give not only a lucid exposition of the structural relations of the synthetic organic thermoplastics, such as polymethyl methacrylate, polyvinyl chloride, nylon, polythene, polyisobutylene, but also to demonstrate the variations in their properties, with a deftness and nonchalance that a conjurer might have envied. This he followed up by indicating clearly and concisely what is involved in the industrial development of such products: the close co-operation of the organic and the physical chemist, the physicist, the chemical engineer and the engineer, and the importance of the development of knowledge of the fundamental principles of plastic flow, and the perfection of methods of measurement both in regard to the application and the manufacture of plastics, though Dr. Swallow observed that in such industrial developments there is art as well as science. Above all, it is important to have available as many clarifying principles as science can provide, relating properties to structure, in order to be able to select and concentrate on the development of those plastics likely to be the most useful and to prevent dissipation of research effort.

The story which Mr. A. L. Bacharach had to tell of the synthetic vitamin industry was no less fascinating; and if the session seemed to come to a lame conclusion and the red lights came on insistently for the first time, it was rather because of Mr. Bacharach's failure to prepare his material adequately with reference to the time factor, so that discussion of the questions to which his account of the development and possibilities of this new industry, not merely for therapeutics, but also in nutrition and the food industries generally, naturally led, was prematurely terminated. Mr. Bacharach pointed out that this new branch of chemical industry is less than twenty years old, and that not all the products are in the strict sense synthetic; they may be extracted from natural sources or degraded from natural compounds. All the important discoveries on which the industry is based were made in university or institutional laboratories, and even the isolation, purification or determination of constitution was effected in such laboratories and not in industrial laboratories. The type of problem is one calling almost solely for the co-operation of the organic chemist and the chemical engineer. Finally, Mr. Bacharach emphasized the identity of the natural and synthetic vitamins, and the widely varying scale on which the various processes of manufacture are carried on.

The final session of the Conference was devoted to "The Future: What Science might Accomplish", and in presiding over this session, Lord Woolton spoke of the lessons for peace of war-time triumphs. Rejecting alike the totalitarian approach with its abandonment of freedom and the *laissez-faire* doctrine of trusting to chance, Lord Woolton believes that public opinion will demand that in certain spheres the Government should exercise a greater influence than it did before the War, and that if we use the knowledge we have gained of necessity in war, we have much material on which to reconstruct a healthier and happier society in the future. Within a few weeks of his taking office as Minister of Food in April 1940, we were faced with a 50 per cent drop in our food imports, and were saved from starvation by the application of scientific knowledge to the problem of securing the right foods, not to satisfy our appetites, but to meet nutritional needs. Advances which scientific research has made in handling food, such as dehydration, both saved shipping space and preserved food, while in agriculture scientific research has made it possible to increase yields beyond all expectation. Steps taken to increase the consumption of milk, to encourage the eating of selected vegetables, to provide certain classes with orange juice, cod-liver oil, vitamins and calcium tablets, to develop communal feeding and meals in factories, and to expand the scheme for meals in schools, should form a permanent part of our health programme. Lord Woolton urged the British Association to continue its educational work in the field of nutrition, and said that in the fields of housing, in trade and industry, and the effective use of man-power, we should also seek to turn to account the lessons and experience of the War. He fully agrees that post-war reconstruction should begin with housing: that involves determining the standard of housing that will enable people to live healthy lives, and then the application of scientific knowledge to the design and construction of houses.

For the best uses to be made of our scientific resources, there must be closer contact between scientific workers in industry and those in the universities, more integration between research and development, and more pooling of information about new developments. The State and industry must see that scientific research, whether medical, agricultural, industrial or fundamental, is adequately endowed.

Mr. E. Carter followed with a paper on science and housing, in which he pointed out that the comparatively few advanced modern houses built between the Wars must be regarded as laboratory models rather than parts of a housing achievement. He urged that housing should be considered as primarily a social problem, taking account of potentialities rather than actualities. The contribution of science, he suggested, has three aspects: definition of the problem, which involves a large extension of a scientific survey of the attitudes of people to their domestic life and equipment, of the dynamics of family living, and of the physical factors that govern house plan and equipment, sizes and shapes. Secondly, we have to provide solutions, bring all our techniques, material and equipment to a high pitch of efficiency and to co-ordinate them into integrated designs for dwellings and communities. Finally, there is the operations stage—the business of economics, scientific manage-

ment, production and job supervision. Scientific workers, said Mr. Carter, are not happy working to make low standards tolerable, nor will they for long be content to design high standards which cannot be translated into the real life of the mass of the people

No brief summary could do justice to this highly suggestive paper or to those which followed from Sir Joseph Barcroft on food and from Prof. J. M. Mackintosh on health. Sir Joseph Barcroft, pointing out how little we know of nutrition in regard to the brain, gave a glimpse of the possibilities if the nourishment of our central nervous system could be placed on an ascertained basis. Predicting a great change within ten years with regard to the certainty of our knowledge of the relation of food to man, Sir Joseph indicated some of the problems, such as those of flavour, requiring investigation, and the decisions which will have to be taken in regard to milk policy, meat policy and the like. He also referred to the shortage of research workers; many more will be required to prosecute on any adequate scale the investigations on the nutritional demands of muscular exercise, mental work and maternal potentiality which lead to rational or functional nutrition

In a brilliant survey of what preventive medicine might accomplish, Prof. J. M Mackintosh suggested that surgical science is still only in the clumsy experimental phase of its childhood, and that plastic surgery has only just begun to take shape. Recent advances in plastic surgery are not merely refinements in technique, but rather the progressive application of new biological knowledge; recent work on the lungs, the nerves and the blood vessels has opened up great highways for the march of science. Surgery has secured a powerful ally in biochemistry, but the mechanical expert is badly needed in the surgical repair shop, and the chemist must be called in to help in the search for non-irritant materials which can be used in surgical architecture. In preventive medicine, Prof. Mackintosh said we must recognize the environmental factors, represented by sanitary science, housing, town planning and the like, and the personal factors, with the family and social background. He stressed the importance of water supply and also atmospheric pollution: smoke prevention is one of the immediate tasks of sanitary science. On the personal side, preventive medicine stands at the door of opportunity, and the brilliant discoveries of bacteriology and biochemistry have yet to be applied. We have still to organize concerted attacks on such problems as tuberculosis, and we should also be deeply concerned with the positive aspects of prevention; there is need, for example, for a new spirit of health organization in industry, especially for the benefit of the smaller occupations and the widely distributed activities of transport and service. Finally, Prof. Mackintosh referred to the possibilities in the field of international health, and urged the importance of co-operation between the medical and other technical experts, in which each should be ready to subordinate his ideal to the common purpose.

Sir Lawrence Bragg, speaking on the place of science in industry, said that although the British have a fine record in pure science and seem to breed the right type of man for breaking new ground, initiating new branches of science and solving old problems in an unexpectedly simple way, there are three bottlenecks which are restricting the vitalizing function of science in industrial and national affairs. First, the fact that science is not yet a recognized part of a good general education, especially the higher education of those from whom the leaders of the future are likely to emerge Secondly, he finds a very general reluctance of the most brilliant of young scientific workers to enter industry; and thirdly, the disposition of young people with a good deal of idealism to desire work directed mainly by considerations of social service. Sir Lawrence Bragg thinks that the War has indicated means of overcoming these difficulties, and finally he pointed out that when we ask what science might accomplish we should also ask what do we wish it to accomplish The higher achievements of the human spirit are founded on man's command over Nature, and the wider and stronger science can make that foundation the higher the edifice which can be built upon it.

In summing up the Conference, Sir Harold Hartley commented that he had not found, as a teacher of chemists, the difficulty to which Sir Lawrence Bragg referred. Emphasizing a number of points which came out, such as the stimulus which science and industry mutually derive from one another, the impact of one industry on another, he referred to the general agreement on the need for greatly increased support for research, and particularly for more endowment by the State, and for making a scientific career really attractive and giving the scientific worker full encouragement and freedom to work in the way in which he can best develop his powers. There is agreement that the shortage of man-power makes it imperative to see that trained intelligence is directed into the right channels, and if the Conference contributes to a general realization of what has been done and how much still remains, it has also clearly indicated something of what is possible if we harness the brain power of the scientific worker to the improvement of the prosperity and welfare of the community.

CROP PRODUCTION IN NUTRIENT SOLUTIONS

By SIR JOHN RUSSELL, F.R.S.

SEVEN years ago Prof. W. F. Gericke, of the University of California, published an article in *Science* under the title "Hydroponics—Crop Production in Liquid Culture Media", and he followed this up in 1940 by a book, "Complete Guide to Soil-less Gardening". The idea attracted certain people very strongly, and before long it was necessary for some of the staff of the University to point out that some at least of the claims that were being put forward lacked good evidence The method was critically but impartially investigated in Great Britain by Prof. R. H. Stoughton, of the University of Reading, Dr G. H. Bewley, of the Cheshunt Research Station, and Messrs. W. G. Templeman and S. J. Watson, of Jealotts Hill, and it is now possible to obtain a much more complete view than could be done before.

In principle, it is the water-culture method familiar to generations of botanists: plants are grown in nutrient solutions and not in soil. But the scale is different. Instead of individual plants each in its own bottle, the plants are grown in considerable number in specially constructed troughs holding the culture solution, the seed or seedling being supported on a specially prepared bed of vegetable litter.

Prof. Gericke has recently pointed out an important difference between the culture medium and the soil which may open up some interesting scientific problems. Hitherto, he says, agricultural chemists have devoted much attention to the relations of the soil and plant growth. The soil was studied as the anchorage for the plant, and the different types of soil were known to induce different types of root development. There is, in fact, some kind of relationship between soil type and the architecture of the root. Further, the soil is the reservoir for water for the plant. It will not give up all that it holds, and much important work has been done on the partition of water between soil and plant. Finally, the soil plays an important part in the mineral nutrition of the plant, holding the phosphates and potash in various degrees of intensity; again there is something like a partition.

Prof. Gericke points out that all these relationships disappear in water culture. What is wanted now, he says, is a study of the plant in relation to the culture solution; and this will obviously lead to very different results from those obtained in connexion with soil.

For a given plant, the root system is much less varied in water culture than it is in soil. Roots in water culture are neither as thick or as thin, nor as long or as short, as they can be in different soil types, nor do they live as long. On the other hand, many more new roots arise from the root crown in water culture than in soil. The effect on total growth varies with the plant. Some kinds of plants make better growth than in soil, others less. This narrowing of the range of variation of the roots leads to a further result: the mineral compositions of different species when grown together in the same nutrient solutions are more alike than when they are grown together in the same soil.

On the other hand, a somewhat wide variation in the composition of the nutrient solution is permissible; there is no optimum ratio of the nutrient elements, nor an optimum pH value. Certain elements, however, are needed in larger amounts than others, and some are toxic if present in excess.

The subject of hydroponics, however, was not put forward to encourage the study of the relations of plant roots to water; it was to be an alternative to soil culture. Experiments in Great Britain have not given results so promising as some of those reported from California. As mentioned above, they have been made at three stations: the University of Reading, Jealotts Hill and Cheshunt. All failed to obtain the huge crops of tomatoes—200 tons per acre—claimed in California; and in fact they obtained no better results than in soil. Prof. Stoughton attributes this to the low light intensity prevailing in Britain and to the difficulty of ensuring adequate aeration for the roots.

As an alternative, Prof. Stoughton prefers sand culture, in which the nutrient solution is periodically pumped up into the vessel containing the plants and then allowed to return to the supply tank; this ensures adequate aeration of the roots and, for certain flowers at any rate, it has given better results than the water-culture method*. The best plants are usually no better than the best in soil, but there is greater uniformity, and in consequence better average yields. Certain difficult plants also appear to grow more freely in sand culture than in soil.

Dr. Bewley's experience has been on similar lines. He did not get better crops of tomatoes in sand culture than in soil, but of course his standards are high and he is no stranger to a crop of 80 tons per acre growing on steamed soil. But he also finds that certain flowers do better in sand culture than in soil. Carnations came earlier and in greater quantity, though it did not appear that their quality was as good as in soil.

Prof. Stoughton arranged for chemical analyses of some of the crops grown in sand culture to see if there was any evidence of inferior nutritional value as compared with crops grown in soil. But none could be found. As against this, Prof. Gericke states that the protein content of plants grown in nutrient solutions does not rise so high as it can do in soil.

Thus it appears that the growth of plants in nutrient solutions opens up a number of scientific problems, especially those related to root growth and the phenomena of flowering, and it opens up also many practical problems which when the War ends will no doubt be seriously studied. But it can be said at once that there is no evidence that any significant contributions to war-time food supply of Britain can be expected from the method.

* For details, see Stoughton, R. H. *J. Roy. Hort. Soc.* 66, 17 (1941).

THE TAXONOMY OF BRITISH BRYOPHYTES AS A FIELD FOR RESEARCH

By Dr. P. W. RICHARDS
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THE note in *Nature*[1] on the recently published history of the British Bryological Society ends with these words: "The taxonomy of mosses and liverworts is now largely established, but many bryological matters still require elucidation. Perhaps the post-war period will provide opportunities for detailed ecological studies—the relation of a moss or liverwort to its substrate, its reactions with other plants, and particularly of its unique physiology, which allows a special phenology of reproduction not possessed by any other kind of plant". With the second part of this statement every student of the bryophytes will be in warm agreement, but the first part, with its implication that taxonomically the bryophytes are an exhausted field, perhaps conveys a misleading impression. It may therefore be worth while to survey briefly the present position of bryophyte taxonomy so far as it concerns the British Isles.

The systematic study of the mosses and liverworts has long been established in Britain. In the eighteenth and nineteenth centuries British botanists made very notable contributions to the taxonomic study of these groups. Since then, though workers on the bryophytes have, of course, been few compared with those concerned with other groups of plants, the British contribution to bryophyte taxonomy has still been large, the work of the late Symers MacVicar and W. E. Nicholson on the liverworts and of the late H. N. Dixon on the mosses being especially important. British bryologists are fortunate in having in MacVicar's "Student's Handbook of British Hepatics"[2] and Dixon's "Student's Handbook of British Mosses"[3] two excellent handbooks in which the known species and varieties are admirably described and figured. Such works as these, however, can never be final or impossible to improve; they should mark the begin-

ning rather than the end of a period of development.

Since the publication of the last editions of Dixon's and MacVicar's "Handbooks" a number of important additions have been made to the British bryophyte flora. The chief additions among the liverworts are *Cephalozia affinis* Lindb. (Jones[4]), *Scapania apiculata* Spruce var. *Jonesii* Nicholson (Nicholson[5]) and *Telaranea nematodes* (Gottsche) Howe (Buch[6], Richards[7]), a member of a monotypic genus previously known only from tropical America and Africa, but afterwards reported from the Azores and western Pyrenees. Further, British workers seem to have overlooked the fact that *Scapania parvifolia* Warnst. and *S. paludicola* Loeske and K. Mull have been recorded as British by Buch[8] Among the mosses the Mediterranean *Cheilothela (Ceratodon) chloropus* (Brid.) Lindb. (Binstead[9]) and the long dubiously British *Cinclidotus riparius* (Host.) Arnott (Nicholson[10]) have been added to our flora, while recently Heslop-Harrison and Cooke[11] have found in the Hebrides *Andreaea Hartmanii* Thed. and *A. Blyttii* Schp., both previously known only from Scandinavia, as well as *Aongstroemia longipes* Sommerf. and *Cirrphyllum (Eurhynchium) Boscii* (Schwaeg.) Grout, the last-named being new to Europe. These discoveries show that among species generally recognized in other countries additions to the British flora are still to be expected.

The main need, however, is not so much for the intensive search for additional species as for a critical re-examination of those long known to occur, especially of those in polymorphic groups. It is generally recognized that both the mosses and liverworts abound in highly plastic species. Though some bryophytes, for example, *Breutelia chrysocoma* (Dicks.) Lindb., *Bazzania trilobata* (L.) Gray, seem to be extremely stable and vary remarkably little, even under the most diverse environmental conditions, many species are notoriously variable, the ubiquitous *Hypnum cupressiforme* Hedw. being an outstanding example. Observations in the field at once suggest that much, though not all, of this variation is due to the direct modifying effect of the environment, by carefully noting how far different variants can be found growing side by side in the same environment, and how far they always occur in obviously distinct habitats, something can be done towards determining to what extent the variation is phenotypic and to what extent genotypic. It is clear, however, that the systematics of these polymorphic species can only be placed on a firm foundation if they are studied experimentally under controlled conditions.

In Great Britain, as yet, practically nothing has been done on these lines, but the work of H. Buch on the liverworts of Finland shows how profitable such researches are likely to be. Buch's methods[12] rest on the simple postulates that, (*a*) genotypically similar types may appear phenotypically different when grown in different environments, (*b*) genotypically different types appear different when grown in the same environment. Wild material of 'critical' species is transplanted either from one natural habitat to another, or from different natural habitats to an as far as possible uniform 'standard' environment—Buch's 'standard' environment consisted of a peat substratum in a wooden box with a loosely fitting glass lid kept in a living-room which was heated during the winter so that neither humidity nor temperature fluctuated very violently. Using these simple methods, Buch obtained results of great interest and significance for taxonomy. His work[13] on the *Lophozia ventricosa* group of leafy liverworts may be used as an illustration.

In MacVicar's "Handbook" eight 'species' in this group are recognized: (1) *L. ventricosa* (Dicks.) Dum, (2) *L. porphyroleuca* (Nees) Schiffn., (3) *L. guttulata* (Lindb. & Arn.) Evans, (4) *L. Wenzelii* (Nees) Steph., (5) *L. confertifolia* Schiffn., (6) *L. alpestris* (Schleich.) Evans, (7) *L. longidens* (Lindb.) Macoun, (8) *L. longiflora* (Nees) Schiffn. Buch was able to show that of these (1), (2), (4), and (6) were well-characterized species which remained obviously distinct when grown under the same conditions; *L. guttulata* proved to be a modification (phenotypic form) of *L. porphyroleuca* produced by conditions of strong illumination and evaporation, and *L confertifolia* was found to be a parallel modification of *L. Wenzelii*. The status of *L. longiflora* remained undecided. During the investigations the existence of two new species in the group, neither of which has yet been detected in Britain, was disclosed: one of these, *L. silvicola* Buch, is recognized mainly by the highly characteristic appearance of the oil-bodies in the cells, a character which is only observable in living material, the species being impossible to separate from *L. ventricosa* on herbarium material alone. The morphological differences between *L. Wenzelii* and *L. ventricosa*, and between *L. porphyroleuca* and *L. ventricosa* respectively, are comparatively small, and as both *L. Wenzelii* and *L. porphyroleuca* have more specialized habitat preferences (bare rock and rotten wood respectively) than *L. ventricosa*, Buch suggests that they are comparable with Turesson's ecotypes among the higher plants.

In other genera very similar results were obtained. In the genus *Scapania*[8] culture experiments showed that *S. undulata* (L.) Dum., *S. dentata* Dum. and *S. intermedia* (Husn.) Pears were all modifications of one and the same species which could readily be transformed from one into another. The distinctness of *S. undulata* and *S. dentata* as 'good' species had previously been generally accepted In the genus *Calypogeia*, Buch[14] found that what had hitherto been regarded as a mere variety of *C. Neesiana* (Carest. & Massal.) K. Mull. proved to be a thoroughly distinct species when grown side by side with normal *C. Neesiana* under cultural conditions.

Since the modifications of different species under diverse environmental conditions are strikingly parallel, Buch suggests that a uniform system of nomenclature should be applied to the modifications of all plastic species of leafy liverworts. For example, modifications with strongly thickened cell walls which occur under conditions of high evaporation should be called mod. (=modificatio) *pachyderma*, while those with reddish or otherwise pigmented cell walls (found in strongly illuminated habitats) should be called mod. *colorata*. A modification combining more than one such character could be referred to by a combined name, for example, mod. *pachyderma-denticulata-colorata*. Whether this system of nomenclature is feasible can only be shown by experience, but in any event the suggestion is an interesting one as showing the widespread occurrence of parallel phenotypic variations in this group of plants.

It would be of great value to extend Buch's experimental methods to all our polymorphic groups of mosses and liverworts. So far almost nothing of the kind has been attempted for the mosses, though unpublished experiments by the author have shown that the well-known sand-dune moss *Tortula ruraliformis* (Besch.) Dix, which is variously regarded as a

variety or a 'sub-species' of the common inland species *T. ruralis* Hedw., retains its distinctive characters when cultivated side by side with *T. ruralis* under experimental conditions.

The group of mosses to which the application of this technique is most urgently necessary is the genus *Sphagnum*, a genus which, as is well known, has been a fruitful field for the species 'splitter'. Anyone who is familiar with the genus in the field realizes that it is a particularly plastic one in which phenotypic variation is readily induced by differences in water-level, in exposure to light, etc. Warnstorf, who monographed the genus for Engler's "Pflanzenreich", described a vast number of species of which a large proportion are almost certainly merely modifications. Following Warnstorf's delimitation of the species, no less than 47 sphagna have been recognized in Britain, each with a multitude of varieties and forms. Le Roy Andrews[15], on the other hand, on the basis of careful herbarium studies alone, would reduce our number to about twenty-six. In the particularly difficult group of the *Sphagna subsecunda*, Åberg[16], after a very careful study (though without using experimental methods), recognizes only three European species as compared with the eighteen recognized by Warnstorf. In one locality in Sweden he observed a 'natural experiment' in which owing to the falling of the water-level in a lake an originally uniform carpet of *S. subsecundum* Nees var. *innundatum* (Russ.) emend. had become transformed into two modifications, one growing in the water and one above it; these modifications, according to Åberg, would certainly have been regarded by Warnstorf as distinct species.

The introduction of experimental methods is not the only improvement desirable in our taxonomic technique. Great advances can be made by making methods of description more precise and refined; Buch, in his admirable monograph[8] of the *Scapania* species of northern Europe, has shown how much can be done in this direction. Bryophytes are plants in which many taxonomically useful characters (cell size, ratio of length to breadth of leaves, seta length, etc.) are readily measurable and may be treated statistically. Several workers have already successfully demonstrated the value of statistical methods in bryophyte taxonomy (for example, Malta[17], Walther[18], Wynne[19]). As with the higher plants, a combination of cytogenetic with taxonomic methods is certain to be fruitful. Evans[20] showed that all forms of the genus *Dumortiera* fall into one of two morphological groups; afterwards it was shown[21] that in one group the haploid chromosome number was 9, while in the other it was 18. Burrell[22] has suggested that *Orthodontium gracile* (Wils.) Schwaeg. var. *heterocarpum* Watson, which is rapidly spreading in the British Isles, is a polyploid of recent origin.

Up to now this article has been concerned only with the species and minor taxonomic units, but advances can also be looked for in 'major' taxonomy. With changing views on the phylogeny of the liverworts (cf. Harris[23]) and a general recognition that the simpler types are reduced rather than primitive, a need for a revision of the classification has been felt. Classifications in harmony with the new views have been put forward by Verdoorn[24] and by Evans[25]. A check-list of the liverworts of Europe and North America arranged according to Evans' classification has been published by Buch, Evans and Verdoorn[26]; this list embodies Buch's[27] useful subdivision and re-classification of the obviously artificial genera *Lophozia* and *Sphenolobus*.

For the mosses the scheme of classification proposed by Fleischer and adopted with various modifications in the second edition of Brotherus' two volumes on the Andreaeales and Bryales in Engler's "Pflanzenfamilien" has obtained general acceptance among Continental bryologists. In Britain the older classification adopted in Dixon's "Handbook" is still in vogue; but it seems high time that Fleischer's system came into use in Great Britain also.

From this short survey it will be clear that the taxonomy of the bryophytes offers abundant problems for research. There is still much to be done both for the amateur and the professional worker, especially if the words of that stimulating bryological critic, L. Loeske[28], are borne in mind, "Es gibt fur die Systematiker keine hohere Forderung als die, auch zugleich Biologe zu sein". In the British Isles we have an exceptionally rich and varied bryophyte flora. If the great opportunities that lie open to us are not to be lost, more research on bryological taxonomy is required. It is at least to be hoped that after the War one of our great national herbaria will find it possible to appoint a member of its staff whose whole time is devoted to this much-neglected group of plants.

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OBITUARIES

Dr. E L. G. Clegg

THE hand of death has fallen heavily on the Geological Survey of India during the past few years, for we have lost in turn, and at a comparatively young age, Cotter (1941), Pilgrim (1943), and Christie (1944), all retired from the Department. Now we have to lament the death of a serving officer, Dr. Edward Leslie Gilbert Clegg, who passed away on September 8, 1944, some days after an operation in the General Hospital, Calcutta.

At the time of his death Clegg was director of the Geological Survey, having succeeded Sir Cyril Fox so recently as July 1943. For the purpose of helping in the great industrial expansion that is now seen to be necessary if India is to rise to her proper status in the world, the Geological Survey of India is in process of expansion to a strength much greater than before the unfortunate and ill-judged retrenchment of 1931. As Clegg had, throughout his service, shown himself to be possessed of a large modicum of common sense and a flair for administration, he was essentially the man for the job of director, and his untimely death must be regarded as nothing less than a calamity both to his Department and to India.

Clegg was born on February 24, 1894, at Manchester. He was educated at the Central High School (1904–12) and Victoria University, Manchester (1912–15 and 1919–20). He served through the War of 1914–18 as an officer in the Northumberland Fusiliers and saw much active service in France and Italy. After the War he returned to Manchester, took the M.Sc. degree in geology, and was then (1920) appointed an assistant superintendent in the Geological Survey of India.

For his first field-season, Clegg was posted to my party in the Central Provinces, and after accompanying me for a time, he was given an independent piece of work on the Archæans of the Nagpur district. Except for water-supply inquiries, and charge of work in the Central Provinces and of sulphur operations in Baluchistan after his return from Burma in 1942, this proved to be the only field-work Clegg did in India *strictu sensu*. For in his second field-season he was posted to Burma, where practically all his field work was done in two spells. Between these two spells Clegg was at headquarters in Calcutta, first as curator of the Geological Museum, and then as officer-in-charge of the Geological Survey Office. During this period he acted also as lecturer in geology at Presidency College and at the Bengal Engineering College, Sibpur. In addition he took a keen interest in the Mining and Geological Institute of India, acted as one of the joint honorary secretaries during 1927–30, and was vice-president in 1943. He became a D.Sc. of Manchester in 1939.

In 1932 Clegg was promoted to the grade of superintendent, and placed in charge of the Burma Circle On account of the approaching separation of Burma from India, it fell to my lot to devise a scheme by which geological survey work in Burma could be continued after separation; for Burma would then have no geologists, unless a portion of the Indian Geological Survey was to be cut off. The solution adopted was to form a new department, the Burma Geological Department, and staff it with officers seconded (on foreign service) from the Indian Survey for periods of five years at a time, until Burma could recruit her own geologists. Meanwhile the scientific results of the work of the new Department were to be published in the *Records* and *Memoirs* of the Geological Survey of India, and this course has been followed up to date.

The separation took place on April 1, 1937, and Clegg became the first superintendent of the new Department, taking orders direct from the Government of Burma, instead of from the director of the Geological Survey of India. With the invasion of Burma by the Japanese, Clegg returned to India after making a valuable traverse through the Hukawng valley for the military (for a road through to India), emerging at Margherita in Assam in June 1942. It is perhaps not out of place to record that Mrs Clegg, with Mr. and Mrs. Anil Dutt (also of the Indian Survey), travelling by a route since made famous by the 14th Army, escaped from Burma in March 1942 *via* the Kalewa–Kabaw valley and Tamu to Palel in Manipur, walking the whole way, with coolies to carry their few possessions and a servant to push or carry a bicycle. From Palel they continued by motor-bus through Imphal to Dimapur and thence by train to Calcutta.

While in charge in Burma, Clegg had occasion to visit most of the Burmese mineral deposits in order to advise the local government on their mining administration, and on the many problems that arise in the grant of mineral concessions. He also obtained an intimate knowledge of the Burmese oilfields while acting as resident geologist at Yenangyaung in 1935 and 1936. This experience enabled him to write a valuable account of the "Mineral Deposits of Burma", published by the Government of Burma (1940). He also contributed the articles on lead, silver, tin, wolfram, and zinc, to the last "Quinquennial Review of the Mineral Production of India", and finally, in 1944, a bulletin on tin and wolfram to the *Records of the Geological Survey of India*.

On account of his administrative duties, Clegg had less opportunity for systematic field survey work than would otherwise have been the case. Nevertheless he has two important memoirs to his credit. The earlier one, "The Geology of Parts of the Minbu and Thayetmyo Districts, Burma" (*Mem. Geol. Sur. Ind.*, **72**, Pt. 2, 137; 1938), contains an account of his work in these districts, mainly during his earlier spell in Burma. In making use of the writings and maps of his predecessors and of contemporary workers in this and adjoining tracts, Clegg shows a capacity for digesting the work of others and of expounding the combined results with the impartiality of a balanced mind, qualities very useful for the director-to-be of a Geological Survey. Those who wish to follow the tangled story of the nomenclature of the Burma Tertiaries cannot do better than consult this memoir.

On his return to Burma as superintendent of the Circle in 1932, Clegg was set the task, with the assistance of Dr. Narayana Iyer, of making a detailed map of the Ruby Mines area of Mogok, which had already been commenced by Dr. Coggin Brown and Mr. A. K. Banerji, and for which new large-scale maps had been specially prepared by the Survey of India. In three field-seasons Clegg and Iyer completed this survey, but the results have not yet been published. Clegg was not satisfied that the marbles and gneisses of the Mogok tract were Archæan in age, as was generally supposed: consequently he seized every opportunity of making traverses in northern Burma (the defiles of the Irrawaddy, the Jade Mines District, Mongmit State) in a search for clues. This led to important results, with the discovery of a new foraminifer

(*Orbitolina birmanica* Sahni), regarded as of Upper Cretaceous age and found not only in the limestones and mudstones of both defiles of the Irrawaddy, but also in the limestones of the Jade Mines District, which in places are highly crystalline, with rubies and spinels. In consequence wide tracts of Upper Burma, both of sedimentary and volcanic rocks, are now regarded as Cretaceous in age, where rocks of this age were not previously suspected to occur. Clegg gives a full account in his second memoir "The Cretaceous and Associated Rocks of Burma" (*Mem. Geol. Sur. Ind.*, 71, Pt. 1, 1; 1941). As the original inspiration for this work was derived from his study of the Mogok area, it is not surprising that Clegg makes a valiant attempt to show that the ruby-bearing limestones of Mogok are also of Cretaceous age. Unfortunately, in his traverse across Mongmit State in the north to the Mogok area in the south he was frustrated by a "gap of about three miles between the definitely shelly limestone rocks of the Cretaceous series and totally re-crystallised and homogeneous limestones of the Mogok series" (*loc. cit.*, p. 29). The gneissic and schistose rocks of the Mogok area are, however, as highly metamorphosed as those of the Eastern Ghats area of India, or of Ceylon, being uniformly of hypometamorphic grade, including, for example, khondalite (see *Rec. Geol. Sur. Ind.*, 68, 27). I have myself twice visited the Mogok tract, once with Dr. Coggin Brown, and once with Dr. Clegg, and I find it difficult to accept the view that in the main the Mogok tract is not an Archæan outlier of the Indian section of Gondwanaland. The Kamaing granite is, however, definitely intrusive in the Mogok series and may be of the same age as the granitic axis that forms the backbone of the Indo-Malayan Peninsula, and is known to be post-Triassic in age and perhaps Upper Cretaceous. However, Clegg has disturbed the complacency of Archæan enthusiasts, and should the Mogok gneiss, including the marbles, be eventually proved to be of much younger age, to Clegg will belong the credit of having created the doubt.

Besides being a good geologist and administrator, Clegg was a good athlete. He made many friends; and I personally look back with pleasure on times spent together in camp and at social gatherings, as well as to the splendid service he gave in all tasks both executive and administrative with which he was entrusted.

In 1926 Clegg married Helen Goode, a botany graduate of Manchester, and he leaves two sons.

For some of the facts of this note I am indebted to an excellent obituary notice in the October 1944 number of *Science and Culture*, by Dr. H. Crookshank, who has succeeded Clegg as director of the Geological Survey of India.

L. L. FERMOR

WE regret to announce the following deaths

Dr. Guy D. Bengough, F.R.S., consultant to the Chemical Research Laboratory of the Department of Scientific and Industrial Research, on January 20, aged sixty-eight.

Sir Buckston Browne, honorary fellow of the Royal College of Surgeons, a generous benefactor of the British Association, on January 19, aged ninety-four.

Sir Henry Gauvain, past president of the Sections of Electrotherapeutics and of the Diseases of Children of the Royal Society of Medicine, an authority on tuberculosis, on January 19, aged sixty-six.

NEWS and VIEWS

Prof. G. M. Bennett: Government Chemist

PROF. GEORGE MACDONALD BENNETT has been appointed to succeed the late Sir John Fox as Government Chemist. His appointment recalls those of two previous Government Chemists, Sir Edward Thorpe and Sir James Dobbie, each of whom was professor of chemistry before becoming Government Chemist.

Prof. Bennett received his earlier education at the East London (now, Queen Mary) College and proceeded to St. John's College, Cambridge, of which he later became a fellow after taking first classes in Parts I and II of the Natural Sciences Tripos. In 1917 he began original investigations in physical chemistry and on chemical problems of national importance at the time. After leaving Cambridge he was appointed successively demonstrator in chemistry at Guy's Hospital Medical School, lecturer in chemistry in the University of Sheffield and Firth professor of chemistry there in 1931. He was appointed to his present professorship in chemistry in the University of London at King's College in 1938. Prof. Bennett is also honorary secretary of the Chemical Society—an arduous office which brings the holder into contact with chemists generally and with chemical and organization problems of diverse types.

Prof. Bennett's record as an investigator is outstanding. He has made major contributions particularly to organic chemistry and to the stereochemistry of sulphur compounds. He is a crystallographer, and his application of this science in his stereochemical investigations has been of great importance. As a physical chemist he has contributed to our knowledge of surface energy, valency angles and the mechanism of the formation of heterocyclic ring systems. It can be confidently predicted that Prof. Bennett's tenure of the unique office of Government Chemist will be distinguished from all points of view; he has a ripe experience not only of many branches of his subject but also a wide knowledge of men and affairs.

Chair of Chemical Pathology, University College Hospital Medical School: Prof. C. Rimington

DR. RIMINGTON, former scholar of Emmanuel College, Cambridge, has been appointed to the chair of chemical pathology at University College Hospital Medical School. After a distinguished career in Sir Frederick Gowland Hopkins' laboratory at Cambridge, he organized the Biochemical Research Department of the Wool Industries Research Association at Leeds, and then for six years held a senior research fellowship of the Empire Marketing Board at the Onderstepoort Veterinary Research Laboratory in South Africa. In 1927 he was appointed to the staff of the National Institute for Medical Research, Hampstead.

Dr. Rimington's work has covered many fields of biochemistry, proteins, plant poisons and porphyrins,

to each of which he has made noteworthy contributions. In the field of protein chemistry he enlarged our knowledge of the phosphoric acid esters present in casein and of the serum glycoproteins: and latterly with his colleague, I. W. Rowlands, he has turned his attention with outstanding success to the important glycoprotein, gonadotrophin of pregnant mares' serum, a problem of great veterinary interest. During his stay in South Africa, Dr. Rimington worked on the constituents of plants poisonous to stock and from this made an incursion with J. I. Quin into the photosensitization of animals by phylloerythrin. With P. J. Fourie he discovered the first living cases of congenital porphyria in animals, and this has led to numerous contributions to the porphyrin field of pigment metabolism, on which he is an acknowledged authority. Without doubt Dr. Rimington will be received with welcome at University College Hospital Medical School, for his capacity for collaboration has been a valuable and invariable asset.

Geological Society Awards

THE Council of the Geological Society has made the following awards: Wollaston Medal to Prof. O. T. Jones, emeritus professor of geology in the University of Cambridge, for outstanding contributions to knowledge concerning the stratigraphy of Lower Palæozoic sedimentary rocks of Wales; Murchison Medal to Dr. W. Campbell Smith, keeper of minerals in the British Museum (Natural History), for his work on petrology and mineralogy, and his long service as secretary to the Society; Lyell Medal to Dr. L. F. Spath, of the Geological Department of the British Museum (Natural History), who is the foremost expert on the Ammonoidea and on the classification and evolution of the Cephalopoda; Bigsby Medal to Prof. L. R. Wager, of the University of Durham, for his outstanding researches, mainly in petrology, on East Greenland, the Sikkim Himalaya and the north of England; Prestwich Medal to Mr. A. S. Kennard, for his studies of Pleistocene faunas particularly of the non-marine mollusca; Wollaston Fund to Dr. D. R. Grantham, for his work on the Geological Surveys of Tanganyika and British Guiana, especially in the field of mining geology; Murchison Fund to Dr. W. A. Deer, for his researches on rock-forming minerals and petrology, especially of Scottish rocks; and his contribution to the description of the layered intrusion at Kangerdlugssuak in Greenland; one moiety of the Lyell Fund to Mr. A. H. Taitt, of the Anglo-Iranian Oil Company, Ltd., for his work on the exploration for oil in Great Britain, especially on the Nottinghamshire oilfield; another moiety of the Lyell Fund to Dr. F. B. A. Welch, of the Geological Survey of Great Britain, for his additions to our knowledge of the geology of south-west England, both above and below the Mesozoic unconformity, especially in relation to the complicated structures of the Mendips.

Display and Bower Building in Bower Birds

THE annual cycle of display and bower building by *Ptilinorhynchus violaceus* Vieill, the satin bower bird, was discussed in *Nature*, **153**, 685 (June 3, 1944), by A. J. Marshall. He stated that this cycle is possibly due to the effect of increasing light and that stimuli from the bower act "through the anterior pituitary" upon the gonads. The selection of coloured decorations by the male matches the epigamic colours of the female and may "serve the function of exciting himself by their resemblance to female colours". It is regrettable that Marshall omitted reference to published work on these lines when mentioning investigations carried out during 1939–41. In "A Contribution to the Biology of the Satin Bower-bird" (*Australian Zoologist*, 10, 95: 1941). E. Nubling considerably antedates Marshall's conclusions and in some points differs from them. Nubling found that the bower building is not associated with increasing light, for during 1922–26 he found new bowers principally erected in May and June during decreasing light, and states that in such circumstances the whole proceeding of courtship and nidification fall into the period of decreasing light. Regarding the part played by the pituitary body, Nubling wrote (*loc. cit.*, 119), "the role of the pituitary in connexion with such sexual manifestations as posturing during display or ceremonial is thus apparently a factor of outstanding importance", and he quoted the opinion of F. H. A. Marshall (1929) that sexual posturing in birds exercises a stimulating influence upon the anterior lobe of the pituitary.

Nubling discussed the selection of colours very fully in 1941, and so long ago as 1924 had submitted conclusions which were published by Dr. Casey A. Wood (*Amer. J. Ophthal.*, 8, 120; 1925), as follows: "Nubling's preliminary experiments made with colored disks . . . I shall now report in his own words. '1. Violet, indigo, blue. Any of these colours is collected by these birds, as well as any hue or tint thereof, *without any discrimination*. . . . 2. All the other colours collected correspond to those of the plumage, bill, legs, etc., of the immature male and the female, whose plumage is identical. On this I am almost positive, and many comparisons made, using Ridgway's Color Standards for the purpose, have borne out my contention' ". Wood points out that the irides of the female are of an even stronger blue than those of her mate. In 1941 Nubling wrote again (*loc. cit.*, 117) that the "decorations are not collected for the sake of their brightness, but for their colours . . . they represent the insignia, so to speak, of his female mate. The presence at the bower of objects bearing her colours is then not so much for the purpose of attracting the female, but for his own stimulation; they act on him in the way of an aphrodisiac". Nubling compared the exciting colours with Ridgway's 1912 Colour Guide: it seems that the "lemon-yellow" mentioned by A. J. Marshall is so masked by grey that the resultant effect is erroneously described as lemon-yellow; it corresponds to Ridgway's "deep greyish olive", the colour of the upper surface of the female. This is produced by a structural effect, combined with superposed yellow lipochrome, the black plumage of the male giving a blue structural effect.

Health Problems in War-time

BRIGADIER-GENERAL J. S. SIMMONS (*Brit. Med. J.*, 572, Oct. 28, 1944), speaking at the seventy-third annual convention of the American Health Association at New York on health problems during the past year or so in Italy, Sicily and north-west Europe, said that the public health programme is being carried out by a very small number of American and British medical officers and that it was necessary to rely upon local medical men. The greatest problems so far had been typhoid fever, dysentery, typhus fever, smallpox, malaria, venereal disease and scabies. In Italy and north-west Europe the incidence of typhoid

and paratyphoid fever rose after the military operations, but outbreaks had been limited to relatively few communities. The peak was reached in January 1944, when more than a million new cases were reported; but the outbreak was controlled so quickly that only 39 cases were reported during the last week of February 1944. Typhus had not yet been a problem in north-west Europe. Two outbreaks of smallpox had occurred in Italy, but none in north-west Europe. In February 1944, measures for the control of malaria were inaugurated in south and central Italy.

The United States War Department announced, on October 4, that tetanus had been virtually eliminated from the United States Armed Forces by compulsory immunization of all officers and men. No case had been reported among completely immunized troops, but a handful of cases had occurred when immunization had not been complete. Up to September 15, 1944, no cases had occurred in the United States Navy, which also requires compulsory immunization. Brigadier-General R. W. Bliss, assistant surgeon general, United States Army, said that, during a recent tour of the Pacific War theatre, he did not see one mosquito or fly. "When we first took over the Pacific Islands," he said, "there were clouds of insects everywhere, actually making it difficult to see. To-day, if we locate one mosquito, we consider it comparable to finding a four-leaf clover. To me, that's the outstanding achievement of medical science in this war." There were no malaria-carrying mosquitoes in Saipan, but there were species which carried dengue fever. After a few weeks of insect control, dengue fever, of which there had been a great many cases, practically disappeared. Medical sanitary companies divided the island into squares and drained and filled in swamps constantly. "The amazing D.D.T. insecticide, which did such a wonderful job in controlling typhus in Naples, was sprayed by hand and by planes."

Birds in Agriculture

DEFINITE evidence on bird behaviour is ever valuable, especially as regards agriculture, and Mr. A. Roebuck, of the Midland Agricultural College, has done well to put on record in the form of a leaflet five cases in which birds gave help to the farmer ("Birds in Agriculture." By A. Roebuck. Midland Agricultural College, Sutton Bonington). Rooks, lapwings and blackheaded gulls were the species that in these instances did much good work with regard to wireworms (*Agriotes obscurus*), dungbeetles (*Aphodius pinetarius* and *A. inquinatus*), leatherjackets (*Tipula paludosa*) and cutworms (*Agrotis segetum*). Of course, it has long been known that these birds take such agricultural pests, but here we have facts lucidly set forth that show how useful they are in the economy of the farm.

Empiricism and Descartes' Dream Situation

THE problem of determining the status of empirical propositions continues to exercise the minds and engross the attention of philosophers more than any other philosophical problem. The easy solutions of the logical positivists are being slowly torn to pieces by the more leisurely consideration of philosophers who, while sympathetic towards the general attempt to distinguish among propositions between the empirical sheep and the metaphysical goats, are yet suspicious of the ways of doing it. The attempt to find an empirical content for all genuine propositions gives rise to a number of problems. In the seventeenth century, Descartes had expressed the view that as the senses sometimes deceive, they *might* do so always. Therefore he concluded that he might be dreaming, no matter how wide awake he seemed to himself to be. Can one maintain this position without self-contradiction?

In a paper "On the Relation of some Empirical Propositions to their Evidence" (*Mind*, Oct. 1944), Mr. C. Lewy discusses whether it is self-contradictory to say that "I have all the evidence which I do have for saying that I am not now dreaming, and however many tests I may make in the future, they will all confirm this evidence, but I am now dreaming" (p. 289). The paper is long, subtle and difficult to follow. The point of the discussion, when reached, consists in the author's showing that the first part of the statement quoted makes the demand that all the evidence that turns up should be positive, whereas the second part demands at least one piece of negative evidence. There could not be a situation which fulfilled these two conditions. The author concludes not, as might be expected, that the statement is self-contradictory, but that to the question whether it is or not, no answer is possible.

Fixing Confidence Limits to Measurements

IN a paper read in London by H. J. Josephs before the Institution of Electrical Engineers on January 19, the author discusses the problems involved in the application of simple tests of significance to small sets of measurements. The paper opens with an account of the *w*-test, which applies to normally distributed variables, and this is followed by a description of the *t*-test, which is of particular use in dealing with a small number of observations. A method of rapidly applying this test is given, and it is shown that if the true mean value of a physical quantity is unknown, the confidence limits to be attached to an estimated value obtained from the measurements may be determined easily. A quick method is described of estimating the standard deviation of a set of measurements, and it is shown that for very small samples the extreme-mean or median forms a good alternative to the arithmetic mean and is often easier to calculate. Pearson's χ^2 test of goodness-of-fit is explained and illustrated, emphasis being placed on the flexible nature of this test and its relationship to the *w*-test. The elementary tests of significance described involve only a small amount of simple arithmetic, so that they enable an engineer to replace guesses or tentative estimates by well-founded probabilities, and to assess the reliability of some of his results. No mention is made in the paper of the design of large-scale experiments, for which these simple tests are of value in rapidly analysing the data obtained from preliminary trials.

Earth Tremor of December 30, 1944, in Britain

A CONSIDERABLE number of personal experiences of the earth tremor have now been received, and it appears that in some places the tremor reached intensity 5 on the modified Mercalli scale (*Nature*, Jan. 6, p. 15). In Yorkshire, the intensity was greatest in an elongated area near Skipton, and the only damage reported in this county was one chimney which developed a crack, possibly as the result of the shock, and had to be felled. An inquiry has

been made concerning possible sounds associated with the tremor, and three definite observations have been made, all supported by independent observation. (1) A rumble · typical observation by Dr. J. R. Ashworth, of Rochdale, who writes, "I heard a very audible rumble accompanying the swaying movement of the house". (2) A sound like a rushing wind, often said to have been followed by a thud, all taking place at the same time as the swaying. (3) No sound. this was the experience of many who felt the tremor and "knew it could not be bombs because there was no sound". So far, no systematic geographical distribution of the observations of the different types is apparent. In one area observations of all three types were reported. Miss E. F. Bellamy, of the University Observatory, Oxford, felt the earth tremor; but the seismograph at the Observatory was not working at the time The tremor was not recorded on the disk of the Jagger shock recorder belonging to the British Association, then and now working at Comrie. The tentative reading of the record of the tremor obtained by Mr. E. W. Pollard at Binstead, Isle of Wight, shows that it recorded at 00h. 36m. 27s G.M.T., and Mr. Pollard remarks that the record he obtained was similar to those resulting from "a tank passing at 100 yds., (2) a submarine depth charge at 5 miles, (3) the Burton explosion". No news has yet been received of any possible recordings by seismographs outside the British Isles.

Report of Seismological Investigations Committee

THIS Committee of the British Association has just issued its report for 1944. This is its forty-ninth report, and it first records with regret the death of Dr. F. J. W. Whipple, who was chairman of the Committee during 1931–39. It is remarked that Whipple was primarily responsible for the leading place which Kew took in seismology, and it was also due in no small measure to his interest, enthusiasm and skill that the International Seismology Summary (published at Oxford) received such generous support from the International Geodetic and Geophysical Union. During the year there has been no alteration in the location or working of the instruments belonging to the Committee which are out on loan. The Milne-Shaw seismographs are at Oxford, Cape Town, Perth (Western Australia), Edinburgh and Fiji. There is also a clock at Fiji and a Jagger shock recorder at Comrie. Thanks are expressed to the collaborators. Two complete recording units have been dispatched to Bombay, and three spare clocks to Poona. Four Milne-Shaw seismographs are under construction for Bombay. Under war conditions, the preparation and publication of the International Seismological Summary is the sole responsibility of Miss E. F. Bellamy of the University Observatory, Oxford. The first quarter for 1935 has been published and partially distributed, while the computation is complete to the end of July 1935.

Committee on Aids for the Deaf

IT has been announced in the House of Commons that the following committee has been appointed to advise and assist the Medical Research Council in promoting research into electro-acoustical problems relating to the design and application of instruments in alleviation of deafness: Dr. W. G. Radley (chairman), Mr. E. J. Barnes, Sir Lawrence Bragg, Mr. N. Fleming, Dr. C. S. Hallpike, Mr. L. C. Pocock and Dr. T. S. Littler (secretary). The Committee has formulated a detailed programme of research, and investigations in which physicists are collaborating with otologists and physiologists are in progress.

Linear Intercepts, Areas and Volumes

IN the two theorems stated by S. I. Tomkeieff in a communication under this title in *Nature* of January 6, p. 24, the word "by" was printed instead of "to". The theorems should read as follows:

"1. The average linear intercept of a convex polygon circumscribed to a circle is equal to the average linear intercept of the circle.

"2. The average linear intercept of a convex polyhedron circumscribed to a sphere is equal to the average linear intercept of the sphere."

The Night Sky in February

NEW moon occurs on Feb. 12d. 17h. 33m. U.T. and full moon on Feb. 27d. 00h. 07m. The following conjunctions with the moon take place: Feb 1d. 03h., Jupiter 4° N.; Feb. 10d. 22h., Mars 0·1° S.; Feb. 15d. 20h., Venus 8° N; Feb 21d. 21h., Saturn 0·6° N.; Feb. 28d. 06h., Jupiter 3° S. The following occultations of stars brighter than magnitude 6 take place: Feb. 19d. 18h. 24·4m., δ Taur. (*D*); Feb. 19d. 19h. 14·2m., 64 Taur. (*D*); Feb. 19d. 20h. 09·6m., 68 Taur. (*D*); Feb. 23d. 2h. 36 8m., 63 Gemi. (*D*). The times refer to the latitude of Greenwich and *D* refers to disappearance. Mercury rises at 7h. 04m. at the beginning of the month and is not well placed for observation; on Feb. 28 the planet is in superior conjunction when it rises at 7h. 07m. Venus is an evening star and sets at 21h. 10m. and 21h. 53m at the beginning and end of the month respectively. Mars is too close to the sun for favourable observation. Jupiter can be seen throughout the night, rising at 20h. 54m. and 18h. 48m at the beginning and end of the month respectively. Saturn sets at 5h. 41m on Feb. 1 and at 3h. 52m. on Feb. 28.

Announcements

PROF. HAROLD LASKI will deliver the first public lecture of the British Association of Chemists at the Caxton Hall, Westminster, on February 14, at 6.30 p.m. His subject will be "The Place of the Scientist in Post-War Administration". Anyone who is interested is invited to attend.

THE Maharaja of Travancore Lord Curzon Prize of the University of Madras has been awarded this year to Mr. S. Rajagopalan of the Indian Institute of Science, Bangalore, for his thesis "Essays in Chemotherapeutical Synthesis", representing the most meritorious original investigation in the physical sciences.

THE following appointments have recently been made in the Colonial Service: F. H. B. Blackburn, to be agricultural chemist, Barbados; J. V. Harbord, to be agricultural superintendent, British Guiana; T. E. Ryall, to be agricultural officer, Nigeria; J. B. Smart, to be assistant conservator of forests, Kenya; A. Jefferiss, to be chief fruit inspector, Palestine; W. J. Badcock, agricultural officer, Uganda, to be senior agricultural officer, British Solomon Islands Protectorate; W. H. B. Buckhurst, assistant director of lands, mines and surveys, Fiji, to be director of lands, mines and surveys, Fiji.

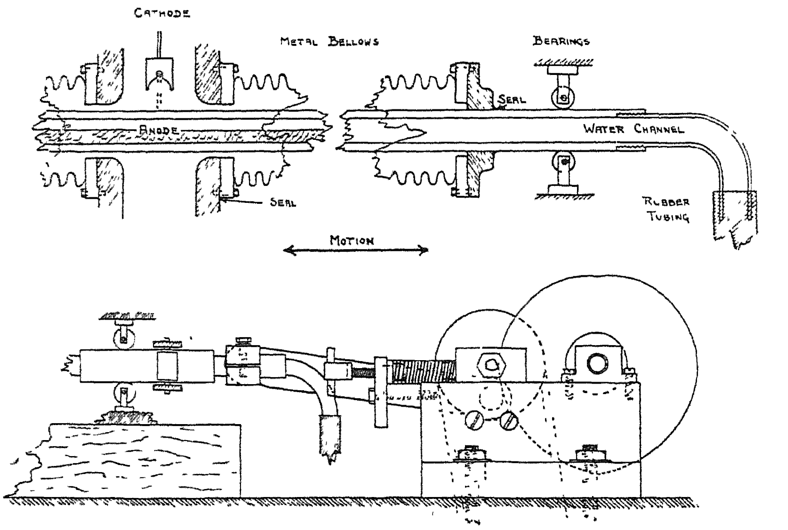
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Simple Moving-Anode X-Ray Tube

THERE have now been described a number of moving-anode X-ray tubes, including the mercury-sealed type developed in this Laboratory[1-4], and their high performance may be regarded as established. They are, however, mostly expensive and not easy to build, and for the future welfare of X-ray structure analysis, particularly in the fibre and protein fields, something is needed for workers with modest resources—something that does not aim at the power that can be realized with a rotating anode, yet is considerably better than the stationary-anode tubes commonly in use. We have designed and constructed such a simple, demountable and inexpensive tube as follows.

The anode is a 5-ft. long horizontal copper tube, either of square cross-section or of circular cross-section with a plane surface in the central region, that is mounted on roller bearings at the two ends and oscillates with a stroke of 4 cm at 3 complete oscillations per second. The vacuum is maintained by two lengths of metal bellows sealed on to the X-ray tube at their inner ends and on to the anode at their outer ends (see upper diagram). The drive is by means of a con-rod and wheel, belt-driven from a light Klaxon reduction gear; but to avoid repeated stationary points at the ends of the simple harmonic motion the axle of the wheel is also moved more slowly backwards and forwards over a ½-in. path by means of a friction drive against a cam (see lower diagram). The fast stream of water that passes along the central bore of the anode is admitted and taken away by pieces of stout rubber tubing at right angles to its length, so as to eliminate shaking by the oscillation. Also, to attain the speed and turbulence for efficient cooling, the bore at the focal-spot region is suitably constricted, for example, by a wooden insert.



This first model is admittedly experimental, and we envisage improvements in the near future as regards design of target, its distance from the X-ray windows, and neutralization of end-effects; but results obtained already are so gratifying that it is worth while quoting some of the principal dimensional features. The central flat of the anode is rather more than ½ in. across and its thickness with respect to the water flowing underneath is 2 mm The metal bellows (the present pair were supplied by the Power Flexible Tubing Co., Ltd.) are each about 18 in. long and 2 in. external diameter, and so far they have oscillated for many hours without showing any signs of injury. (They are of the usual copper-zinc alloy, but we anticipate considerable advantages in elasticity and fatigue limit from the new copper-beryllium alloy that has recently been described[5] Other seals are also possible) The tube, of hot-cathode type (but, of course, moving anodes are equally applicable to gas tubes), incorporates two water-cooled windows (an important feature uncommon in rotating-anode tubes), an insulating body consisting of a miner's lamp glass as in the Shearer gas tube, and the tantalum filament, focusing cup and cathode already found advantageous in producing a sharp line-focus[3,4]. This line-focus (at right angles to the length of the anode) foreshortens, for an emergent beam at 6° to the horizontal, to an area effectively 0·75 mm. × 0·6 mm.; with such a focus we have run the tube at 44 ma. and 28 kV. and taken good photographs of ramie in 2 minutes at D 2 cm. with a ½ mm. slit.

The whole apparatus is remarkably quiet and unobtrusive: it may be mounted centrally along the usual laboratory bench with a spectrometer on each side and the pumping equipment immediately underneath. An adaptation that suggests itself is to have a single (longer) anode, sealed by a single pair of bellows, running through a series of X-ray tubes on the same bench; and it would be possible, too, to have a composite anode that included sections made from different metals. Two similar tubes, with a common anode and set at the requisite distance apart, might form an excellent arrangement for the purposes of high-speed stereoscopic radiography.

Full details will be published elsewhere. The junior author thanks the International Wool Secretariat for tenure of a research fellowship.

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Dec. 12.

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Nuclear Histone from Bird Erythrocytes in the Preparation of Insoluble Insulin Compounds

FOLLOWING early work done in these laboratories on the use of thymus histone for the preparation of a histone-zinc-insulin with prolonged hypoglycæmic activity[1], we have now tried a histone from the nucleus of bird erythrocytes.

Drs. Lajmanovich and Mittelman directed our attention to this protein; it is usually classified as a histone, but they found in some reactions that it shows some properties of the protamines. We thank them for preparing the histone we employed, from turkey erythrocytes, by a modification of the method of Kossel[2].

A suspension of histone-zinc-insulin (histone from erythrocytes), at pH 6·8, and containing 40 I.U. insulin per c.c., was prepared by the usual procedure.

When administered to diabetic dogs, a fall in the blood glucose took place that lasted for a little more than twenty-four hours, when the initial glycæmic value was again obtained.

The type of glycæmic curve (glycæmia-hours) was similar to that obtained when the same amount of protamine-zinc-insulin (protamine-salmin) was administered. The hypoglycæmic action of the same amount of histone-zinc-insulin (thymus histone) was never so prolonged.

In conclusion, it can be stated that the histone-zinc-insulin complex prepared with histone from the nucleus of turkey erythrocytes has a hypoglycæmic activity more like that of protamine-zinc-insulin than that of the thymus histone-zinc-insulin preparation.

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Detection of Chemotherapeutics in Thin Sections of Tissue by the Aid of Fluorescence Microscopy

IT has long been known that, thanks to their property of showing fluorescence in ultra-violet light, certain substances can be demonstrated even in very low concentrations. As a large number of the common drugs show fluorescence, it would appear reasonable to endeavour to demonstrate their presence also in tissues by the aid of fluorescence microscopy. The method has not been used very greatly, however, in view of the fact that the natural fluorescence of the tissues is so strongly blue that it masks the fluorescence of the drugs administered. In addition, the histological methods used have not excluded the possibility of changes in the locality and concentration of the substance sought during the actual preparation.

I have therefore adopted Altmann-Gersh's freezing-drying method for fixing and drying the sections, in doing which I have made use of a modification which has recently been described in detail by F. Sjöstrand[1]. The principle is as follows. The organs and pieces of tissue to be studied are removed and immediately frozen in liquid air. They are then dried over phosphorus pentoxide *in vacuo* in a refrigerator at about $-40°$ C. They are embedded in paraffin and cut into histological sections, which are mounted on slides, and are then ready for microscopical examination.

Drugs of which the fluorescence colour is other than blue can be demonstrated directly in the sections For example, Prontosil rubrum and soluble, which have a strong red fluorescence, can be demonstrated[2] even in a concentration of $1 \times 10^{-10}\,\gamma$ per μ^3, which is a considerably greater sensitivity than that obtained by observing the natural colour in an ordinary light microscope.

Drugs with blue fluorescence can frequently be made to change their fluorescence colour by heating in a small electric oven to different temperatures for different lengths of time. Sulphathiazole, for example, turns yellow on being heated to 170° C. for 5 minutes, the tissue itself remaining blue. This produces a beautiful contrast, allowing of the location of sulphathiazole in tissues and cells In an ordinary light microscope, no traces of sulphathiazole can be discovered in such sections, any more than is possible in a fluorescence microscope before heating.

By the aid of this method it is possible to demonstrate the presence of a number of drugs, for example, sulphanilamide, sulphapyridine, papaverine, inulin (yellow after 3 min. at 200° C., the tissues still being blue), etc. Penicillin, which has a green fluorescence, can be identified without difficulty in muscle after an intramuscular injection and after the sections have been heated to 175° C. for 5 min.; the penicillin is then yellow-brown. In some cases the contrasts are obtained by the substance sought keeping its colour, while the tissues change their fluorescence colour. Sodium salicylate, which has a blue fluorescence, can thus be demonstrated at 200° C. after 5 min., the tissues at that temperature being yellow.

As the natural fluorescence is considerably differentiated, no special staining is necessary to facilitate the identification of the tissues.

By the aid of this method it has proved possible to study in detail the location of chemotherapeutic substances in tissues and their secretion.

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Detection and Determination of Traces of Methyl Bromide

METHYL bromide has many advantages as a fumigant, but suffers from the disadvantage that, over a range of concentrations liable to be encountered during airing, it is harmful to man and not detectable by smell.

The current method of detection, which does not serve for determination, depends on the appearance of a green 'copper' colour in the flame of a Halide detector lamp. This method is, of course, not specific to bromide and is inconvenient under many practical

conditions. A method free from some of these objections has now been devised. It depends on the catalytic combustion of traces of methyl bromide in air on a glowing platinum wire and the determination of the bromine liberated by the coloration of a test paper. The paper is wetted with a pale yellow solution of fluorescein, more or less of which is changed to red eosin according to the amount of methyl bromide decomposed. The apparatus, which is portable, consists of a vertical glass tube towards the bottom of which is mounted a platinum spiral which can be caused to glow by the passage of a current from a small 4-volt cell. The test paper, which is perforated in the middle, is fastened over the top end of the tube. When the current is switched on, a stream of air passes over the spiral and up the tube, which acts as a chimney, and the eosin, which appears as a ring on the paper surrounded by a white border, can readily be matched against standard disks.

By using different periods of testing and different colour standards, determinations of traces of methyl bromide can readily be made over a wide range of concentrations covering those which are of toxicological importance.

A fuller account of this method is being published elsewhere.

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Extraction of Phospholipids in Salmon Roe

In the course of investigations on salmon roe globulin, the interesting observation was made that the phospholipids in the roe are so strongly held by the proteins that non-polar or semi-polar solvents with a low boiling point (pentane, light petroleum, ethyl ether) do not extract any phospholipid at all from salmon roe, which was previously dried at a temperature below 40° C., although the oil can be completely extracted by such solvents.

It was found by Hoppe-Seyler[1] and others that egg yolk lecithin and phospholipids from other sources are partly extractable with light petroleum or ethyl ether, but that their complete removal could only be accomplished by using a polar solvent such as methyl or ethyl alcohol. In no case, however, did he obtain a complete separation of the oil from the phospholipids. Only milk phospholipids have been reported to differ in this respect. Osborne and Wakeman[2,3] found that the phospholipids of milk precipitated together with the proteins were not extracted at all by ethyl ether, although a subsequent treatment with alcohol removed a considerable amount. These authors stated that the non-protein-containing fraction of milk contains phosphorus. Such findings are understandable for milk, which contains only about 27 mgm. of phospholipids per litre, but it was surprising to find no phospholipids in the solvent-extracted oil from salmon roe, while a subsequent extraction with alcohol removed on the average 6 per cent phospholipids. This is about 2,000 times the amount found in milk.

Experiments with salmon roe were as follows: fresh salmon roe was dried at 30° C. in the stream of air from a fan. The dried material was ground to 20–30 mesh and extracted with pentane in a Soxhlet apparatus. The oil obtained by this method contained the pigments; but no phosphorus, as shown by ashing and testing with ammonium molybdate.

The pentane-extracted roe was reground to 50–80 mesh, and thoroughly extracted with methanol in the same Soxhlet apparatus. The phospholipids so obtained had a reddish-brown, waxy appearance and a characteristic odour. They were free from oil. The ash content was about 10 per cent, the phosphorus content between 2·9 and 3·4 per cent, the moisture content 3–5 per cent.

On the average, the roe from sockeye salmon (*Oncorhynchus nerka*) yielded by the above method 12·5 per cent oil and 6·2 per cent phospholipids.

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[1] Hoppe-Seyler, T., *Hoppe-Seyler Med. Chem. Unters.*, **3**, 392 (1867).
[2] Osborne, T. B., and Wakeman, *J. Biol. Chem.*, **21**, 539 (1915).
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Apparent Clearing of the Sky at Dusk

Clouds may disappear by evaporation of the droplets, a purely physical effect, but they may also vanish to the eye, though in fact they remain. It is generally accepted that the eye can distinguish between brightnesses down to the limit of 2 per cent difference, which may be termed the discrimination factor. The best papers on this factor and its variation with intensity are those of Nutting[1] and Hecht[2]. In average daylight for good eyes, the factor may be as low as 1 per cent, increasing for very bright light to about 6 per cent, and for much-reduced illumination rising steeply to more than 60 per cent; but the value 2 per cent holds approximately over a wide range of daylight.

This variation gives the explanation of 'the moonlight effect', since in shadows the general illumination is so low that the discrimination factor rises beyond the difference between adjacent objects which in daylight were distinguishable. Precisely the same explanation holds good in the sky, where differences recognizable in daylight disappear in reduced light in which discrimination may require a 5, 10 or 20 per cent difference. For example, Hewson[3] has calculated that radiation from a source at 25° zenith distance is reduced by 6·6 per cent in intensity in passing through 20 metres of cloud having droplets of 10μ diameter and a droplet water content of 0·1 gm. per cubic metre, as in high cloud. The loss is due to reflexion, absorption being negligible for daylight. Against a dark sky such a cloud is therefore visible until the discrimination factor approaches 7 per cent, which occurs when sky brightness is about 0·01 millilambert, shortly before the end of civil twilight. A similar cloud 200 m. thick reflects approximately 40 per cent, and ceases to be discriminated when the brightness is reduced to 0·0003 millilamberts, namely, about the end of nautical twilight.

There is also another factor tending to lessen the visibility of clouds at dusk. A cloud appears white against the blue sky because the latter scatters light predominantly blue and the former reflects or scatters white light from the sun. But when the sun is well down, clouds are illuminated only by scattered sunlight and starlight. They thus approach more closely to blue—the spectral region to which our dark-

adapted eyes are more sensitive. This lessening of colour difference has a considerable effect in reducing contrast, as may be seen by viewing a sky with scattered broken cloud through a blue glass. Viewing through an orange or light-red glass increases contrast. With a deep-red glass, however, the discrimination factor may be raised and so again contrast difference is reduced.

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Nov. 27.

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[2] Hecht, S, *J Gen Physiol*, 11, 255 (1928)
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Causality or Indeterminism ?

IN *Nature* of November 25, Prof. E. T. Whittaker says "If a coin is tossed a thousand times and the number of occurrences of heads recorded, and if this experiment is repeated a very great number of times, there will be a statistical regularity in the records, which may be calculated by the ordinary theory of probability. Does the calculation . . . involve only the assumption (as regards the tossing) that there is symmetry in the system".

Does this not assume that the hand—or machine—which tosses the coin moves in a 'random' manner. Such an assumption is often made, and the result quoted as if it were an axiom. Is there, in fact, any scientific reason for it ? Would not the hand—or the machine—tend to move in a systematic manner and thus produce a biased result if the action were repeated many thousands of times ? The assumption of symmetry appears to be a condition of the experiment yielding the hypothesized result ; it is clearly not justified by examination of the ordinary coin a human tosses—which is asymmetric—necessarily so if it is to achieve the purpose for which it is tossed.

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IN *Nature* of November 25 there is a letter from Mr. W. W. Barkas together with Prof. E. T. Whittaker's answer, concerning determinism. The reply refers *inter alia* to some experiment, which is apparently very famous, as during the last century nearly every book or treatise devoted to probability cites, describes or refers to, the so-called experiment of tossing a coin, or dice, etc. However, I have some doubts if any of the authors referring to this 'experiment' ever attempted to treat it as an experiment, that is, to repeat it.

As I have done so, although under somewhat improvised conditions. I would like to mention the results obtained, as they may be of interest to some-one else.

I designed a simple device, by which the chosen coin, in fact, a new sixpenny piece, can be placed always in the same relation to the apparatus. A mechanically operated lever tosses the coin upwards a rather small distance with the same pressure exerted in the same period of time and on the same portion of coin, when tossed. The coin falls on a wooden surface covered with cloth, namely, an ordinary writing-desk. Before reaching the desk, the coin revolves several times in the air and after touching the surface it rebounds, as may be expected. The results : after tossing the coin a hundred times with head initially up, it rested with head up ninety-eight times. After adjusting the lever to a slightly different pressure exerted in the next hundred tossings, also with head initially up, the coin fell with head up once only.

I cannot say I was astonished, as I expected such a result, but it seems to me that it proves that the 'chance' of occurrence of head in tossing a coin is simply the result of the force applied, and consequently this experiment has nothing to do with indeterminism in the sense implied by Prof. Whittaker. On the contrary, as the two or one exceptions in position in which the coin falls are obviously caused by slightly uneven pressure (in force and duration) exerted by the rather improvised device, the experiment, after being repeated under strictly controlled conditions, is more likely to be used by advocates of determinism.

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MR. BARKAS in his letter in *Nature* of November 25 says, "My difficulty is that if the final result of, say, one million, or billion, photons is regular (that is, determined), then how can the choice of any . . . be individually indeterminate". I should like to point out that the final result is not strictly regular or determined. With increasing numbers of photons, the fluctuations about the mean become less and less proportionally significant, until, for many purposes, they can be left out of account. The same is true of the pressure of a gas. If we calculate the pressure from observations on a surface sufficiently large, then the fluctuations may be altogether inconsiderable and the pressure can be regarded as constant ; but if we take a surface sufficiently small—say, for example, a smoke particle—then the fluctuations will be large and will be the origin of the characteristic Brownian movement.

I should like to point out further that the argument Mr. Barkas quotes from the Guthrie Lecture cannot be sustained as disproving causality. What, under certain conditions, it does show is that causality fails if parameters are restricted to photons. Clearly, however, in the passage of photons through Iceland spar, parameters associated with the crystal lattice must be taken into account, and when this is done, the argument fails. Apparently von Neumann's argument has a similar weakness[1].

A large number of the facts of modern physics can be unified by means of non-causal laws ; but no case, so far as I know, has yet occurred where causal explanations can be ruled out as impossible. Natural phenomena, as we see them, may indeed permit of unifying descriptions from two totally different points of view. Perhaps, alas, both types of description may fail.

Determinism is probably not applicable outside material phenomena, but in regard to these it has proved a very useful philosophical principle for hundreds of years. Caution is therefore necessary before it is thought of as having 'collapsed'.

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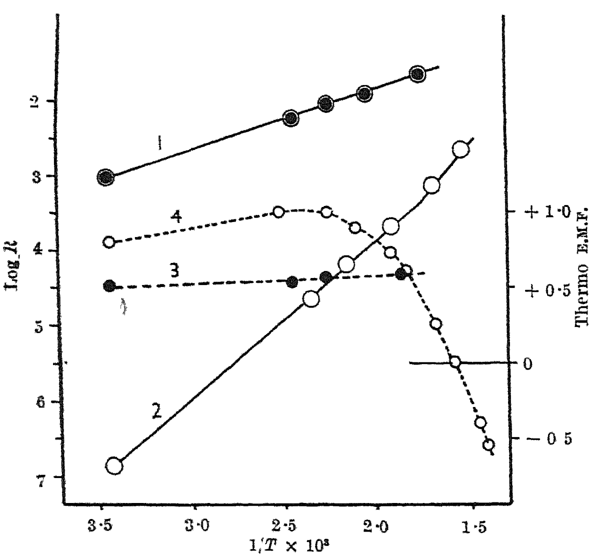
[1] Pelzer, *Proc. Phys. Soc.*, 56, 195 (1944).

Semi-conducting Properties of Stannous Sulphide

In a previous communication[1], we reported that two mechanisms are discernible in the electrical conductivity of stannous sulphide: positive-hole conduction, depending on the departure of the material from stoichiometric composition; and, at higher temperatures, a second mechanism with higher activation energy, fairly reproducible from one sample to another. This high-temperature conduction, we suggested, represents the intrinsic electronic conductivity of the crystal lattice.

We have recently obtained evidence confirming this view from simultaneous measurements, over a wide temperature range, of (*a*) the conductivity and (*b*) the thermo-electric effect of the couple gold – stannous sulphide – gold. At temperatures corresponding to the first leg of the log (conductivity) – $1/T$ curve, the direction of the thermo-electromotive force is indicative of positive-hole conduction (plotted as positive in the graph); its magnitude varies with the stoichiometric composition of the sulphide (0·5–0·6 millivolts per degree for well-conducting material, with activation energy of conduction 0·16 e.v.; 0·8–1·0 millivolts/degree for the same specimen after hydrogen treatment, with $E_1 = 0{\cdot}43$ e.v.), but varies little with temperature while only one conduction process is effectually operative. At temperatures approaching the discontinuity in the log conductivity – $1/T$ curve, the Seebeck electromotive force decreases, becoming negative at temperatures rather above the onset of the high-temperature conduction process (see graph). At high temperatures the current carriers are therefore electrons, and the activation energy of conduction can be regarded as the energy of excitation of an electron to the conduction band of the crystal.

Schottky and Waibel[2] observed an analogous change in the magnitude and sign of the Hall coefficient of cuprous oxide (also a positive-hole conductor at ordinary temperatures, due to the stoichiometric excess of oxygen) at temperatures near the break in the conductivity curve. The behaviour of stannous sulphide thus provides a second instance of the clear identification of the intrinsic conductivity of a semi-conductor.



Curve 1. Log R – $1/T$ curve for sublimed stannous sulphide.
Curve 2. Same, after treatment with hydrogen at 250°.
Curve 3. Thermo-electromotive force – $1/T$ curve for sublimed material.
Curve 4. Thermo-electromotive force curve of material after hydrogen treatment.

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[1] *Nature*, 152, 75 (1943); full account in course of publication.
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Serological Reactions Caused by the Rare Human Gene Rh_z

A rare allelomorph of the *Rh* gene has been described[1,2] and provisionally denoted by Rh_y. This gene differs from the six *Rh* allelomorphs previously found in giving a negative reaction with γ serum, but at the same time a positive reaction with *H* serum. The Greek letters here used for the *Rh* antibodies are those suggested by Fisher[3], but various names have been used:

Γ = anti-Rh_1 (more recently anti-Rh', Wiener) = rho_1 = serum 1 (Murray).
γ = *St* = serum 4.
Δ = standard 85 per cent reacting = *rho* = serum 3.
H = anti-Rh_2 (more recently anti-Rh'') = serum 2.

The reactions of this allelomorph 'Rh_y' with the other two antibodies Γ and Δ were unknown, since in the examples found it had as partner the gene Rh_1, which is itself positive with these two antibodies. Consequently the reaction of the rare gene *per se* was obscured.

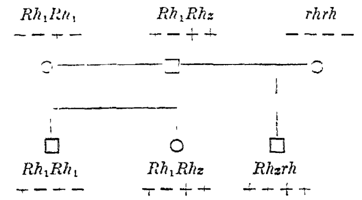
On theoretical grounds, Fisher[3] considered that there were probably two genes which were γ negative and *H* positive, and predicted that one would be Δ negative and the other Δ positive, and that both would be Γ positive. One he called Rh_y and the other Rh_z and assigned to them these reactions.

	Γ	γ	Δ	*H*
Rh_y	+	–	–	+
Rh_z	+	–	+	+

A family has recently been examined in which the father's blood was of the type γ negative *H* positive, which we would previously have called Rh_1Rh_y. The father was the second person in whom this rare gene was found. In a child by his second wife, the rare gene is caught in combination with *rh*, so that its reactions with Γ and Δ are no longer obscured but disclose themselves (for *rh* is negative with both these antibodies). The child's blood was Γ positive and Δ positive, so that the gene present is Fisher's Rh_z. Had the child got Rh_1 from its father its cells would have been negative with *H*, for Rh_1rh is + + + –.

Fisher's main hypothesis gains some support since it demanded that neither Rh_z nor Rh_y would be Γ negative. If later this theory is fully substantiated, the symbols Rh_y and Rh_z will be equivalent to the antigenic formulæ *CdE* and *CDE*.

In previous communications[1,2,4], certain bloods have been called genotype Rh_1Rh_y; they may have been Rh_1Rh_y or Rh_1Rh_z. In the family here described,



(Order of sera, Γ γ Δ H This is not the order used in some earlier communications, which was Δ γ H Γ.)

alone of four families examined, has the rare gene segregated in such a way that its reaction with all four antibodies could be determined: they have turned out to be those proposed by Fisher for Rh_z. The proof of the existence of Rh_y as an eighth gene will probably have to await an equally fortunate segregation

The scheme previously published[3] is here given again with the necessary alterations.

	Genes	Γ	γ	Δ	H
Rh_z	*CDE*	+	−	+	+
Rh_1	*CDe*	+	−	+	−
Rh_y	*CdE*	(+)	(−)	(−)	(+)
Rh'	*Cde*	+	−	−	−
Rh_2	*cDE*	−	+	+	+
Rh_0	*cDe*	−	+	+	−
Rh''	*cdE*	−	+	−	+
rh	*cde*	−	+	−	−

Those reactions not yet determined serologically are given in brackets.

Sera of the Γ, Δ and *H* types, kindly sent from America by Dr. A. S. Wiener, gave with the bloods of this family the same reactions as our sera.

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Nov. 23.

[1] Race, Taylor, Boorman and Dodd, *Nature*, **152**, 563 (1943)
[2] Race, Taylor, Cappell and McFarlane, *Nature*, **153**, 52 (1944)
[3] Race, *Nature*, **153**, 771 (1944).
[4] Race and Taylor, *Nature*, **153**, 560 (1944).

Devernalization by High Temperature

THE possibility of devernalization by high temperature was demonstrated in previous work[1]; but the aim then was to show that it is low temperature rather than restriction of growth which is the determining factor in vernalization. To separate these factors, anaerobic conditions were imposed during the period of high-temperature treatment, and misconceptions have arisen as to the validity of the results on this ground[2,3,4].

Interest in devernalization has led to further work in the U.S.S.R. by Efeikin and by Tetjurev. The former[5] showed that 45 days of vernalization in winter wheat ('Durable') may be annulled completely by 4–5 days at 34–35° C., while one day's exposure to this temperature reduced ear production to 66 per cent of that of the vernalized but unheated controls. Similar results were obtained by Tetjurev[6].

The devernalizing effect of high temperature has been confirmed by us. Winter rye (var. *Petkus*) was vernalized for 42 days at 1° C. and then the seed was subjected to a range of temperatures for varying periods of time. The tempera-

TABLE 1 EFFECT OF TREATMENT AT 35° C BEFORE SOWING ON THE RATE OF EAR DEVELOPMENT (1) IN WINTER RYE VERNALIZED 42 DAYS AT 1° C., AND (2) IN SPRING RYE

Duration of heat treatment	Spring rye (unvernalized)		Winter rye (vernalized)	
	'Score'	No of replicates	'Score'	No of replicates
0 (Controls)	123 ± 0 12	(52)	100 ± 3·0	(47)
8 hours	120 ± 0 77	(48)	95 ± 4 6	(44)
16 ,,	121 ± 0 93	(53)	90 ± 4 9	(35)
1 day	120 ± 0·65	(62)	75 ± 6·5	(35)
2 days	121 ± 0 68	(47)	80 ± 5 9	(39)
3 ,,	124 ± 0 40	(55)	72 ± 9 5	(16)
4 ,,	123 ± 0 46	(49)	72 ± 6 4	(33)
5 ,,	120 ± 0 64	(42)	63 ± 6 6	(35)

tures used were 25°, 30°, 35° and 40° C., and the durations of heat treatment were 8 and 16 hours. 1, 2, 3, 4, 5, 6 and 10 days. The full details will be presented later; here the results for 35° only are given.

Spring rye (var. *Petkus*) was subjected to similar heat treatments without previous low-temperature treatment. The results obtained are entered in Table 1.

The values entered in the Table are means of 'scores' assigned to the individual plants to denote the stage of development reached by the ears at the end of the experiment; the higher the value the more advanced the ear. The method of scoring is discussed elsewhere[7]. A score of less than 50 denotes a stage between an undifferentiated stem apex and the dehiscence of the anthers, and is determined by dissection of the main axis of the plant: values above 50 denote, by difference from the numbers entered, the number of days elapsed after the ear has passed beyond the stage of anthesis. The entries enclosed in brackets are the number of replicates on which the mean value is based. The score attained in this experiment by unvernalized winter rye was 22 ± 0·63 with 40 replications

The following conclusions may be drawn. (1) Heat treatment of the seed is without effect on the flowering behaviour of spring rye. This shows that there is no question of a lethal action concerned. Spring rye heated at 40° C. for 4 days scored 120, thus substantially the same as at 35° C. It may therefore be assumed that the reduction in score seen in winter rye is not due to any injury effect. (2) A progressive reduction in the score accompanies prolonged heat treatment of winter rye, and the downward trend is statistically significant. The delay in flowering is then, presumably, due to the reversal of the vernalization effect. It is interesting to note that in these experiments no complete devernalization occurred. After treatment at 40° C. for 2 days the score was 79 ± 8·0, that is, four times that of unvernalized winter rye, whereas a further day at 40° C. killed all the seed.

Further proof that the delay in flowering noted

TABLE 2 REVERNALIZATION OF WINTER RYE, AFTER HEAT TREATMENT, BY A FURTHER PERIOD OF 6 WEEKS AT 1° C.

Duration of heat treatment	'Score'	No. of replicates
0 (Controls vernalized 12 continuous weeks at 1° C.)	112 ± 1·18	(17)
8 hours	113 ± 0·95	(48)
16 ,,	117 ± 0·82	(41)
1 day	117 ± 0·45	(42)
2 days	113 ± 0·93	(39)
3 ,,	118 ± 0·65	(54)
4 ,,	117 ± 0·63	(54)
5 ,,	116 ± 0·65	(55)

was a true reversal of vernalization was provided by the following experiment. After the preliminary vernalization for 42 days at 1° C., and the following heat treatment for varying durations and temperatures, the seeds were exposed to low temperature for a further six weeks, thus receiving in all twelve weeks at 1° C. The effect on ear development is shown by the scores given in Table 2.

The scores are thus slightly higher than those of the control series which had been vernalized for an unbroken period of twelve weeks. The absence of any effect of heat treatment on spring rye, and the possibility of revernalization by low temperature after the heat treatment, proves beyond doubt the possibility of reversing the normal vernalization process.

An interesting effect noted in the course of this work is that the efficacy of the high-temperature treatment in reversing vernalization depends upon the duration of the previous low-temperature period, and thus upon the 'intensity' of vernalization. This aspect is now the subject of further investigation.

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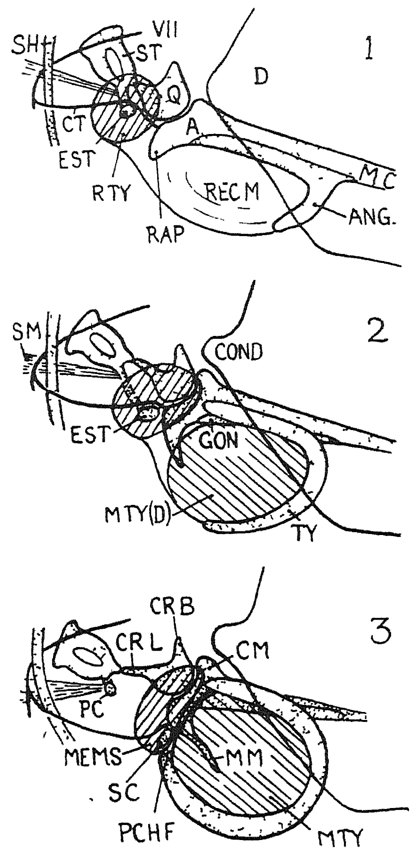
The Mammalian Middle Ear

IN a recent communication in *Nature*[1], certain implications of new work on the anatomy of the middle ear region of mammal-like reptiles were discussed. Some further aspects of the evolution of the mammalian middle ear are here briefly noticed. A new synthesis, based on palæontological evidence, was recently offered[2] to 'explain' the nature of the mammalian tympanic cavity. It was suggested that the primitive reptilian tympanic cavity was, in at least some therapsids, supplemented by a recessus mandibularis related to the region of the notched angular bone; and that the mammalian tympanic membrane was formed from the thin external wall of this recess by extension of the old tympanic membrane.

A feature of the mammalian tympanic region, not found in living 'lower' tetrapods, is the presence of the membrana Shrapnelli, or 'pars flaccida' of the tympanic membrane. As pointed out long ago (reviewed by Bondy[3]), this structure is not really part of the tympanic membrane, from which it is separated in the human subject by the anterior and posterior malleolar folds, which are variously developed in other mammals (the anterior and posterior "Chordafalten" of Bondy). So far as I am aware, Shrapnell's membrane and the *Chordafalten* have never been adequately discussed from the phylogenetic point of view. In the earlier work[2] they were not discussed, but they can be shown to fall clearly into place and to modify some of the details previously set forth.

Shrapnell's membrane seems with great probability to represent the remains of the 'reptilian'



Three suggested stages (diagrammatic) in the evolution of the mammalian middle ear from an advanced theriodont (a cynodont) *A*, articular, *ANG*, angular; *C M*, caput mallei, *COND*, condyle of dentary, *CR B*, crus brevis; *CR L.*, crus longus *CT*, chorda tympani; *D*, dentary; *E ST*, distal part of extrastapes, *GON.*, gonial, *M.C*, Meckel's cartilage; *M E M S*, membrana Shrapnelli, *M.M*, manubrium mallei, *M.TY*. mammalian tympanum, *M.TY.(D)*, developing mammalian tympanum; *P.C*, Paauw's cartilage; *P.C.H.F*, posterior "Chordafalte"; *Q.*, quadrate (incus of mammals); *RAP*, retro-articular process, *REC.M*, recessus mandibularis, *R TY*, reptilian tympanum; *S.C*, Spence's cartilage, *SH.*, stylohyal, *S M.*, stapedial muscle; *ST*, stapes; *TY.*, tympanic bone, *VII*, facial nerve

tympanum of therapsids. Its relations to Spence's cartilage (which probably gives rise to Bondy's "Chordafortsatz"[3,4,5]) support the previous identification[1] of this element with the separated distal part of the extrastapedial. The course of the chorda tympani, allowing for the functional degeneracy of the extrastapedial, also favours this interpretation. Moreover, Shrapnell's membrane (in mammals where it forms part of the outer wall of the epitympanic recess), and the bony walls of that recess, have similar relations to those between the 'reptilian' tympanic membrane of some therapsids and the corresponding part of the bony skull, which differs considerably from the homologous region in living reptiles; the main difference is that Shrapnell's membrane normally extends forward to the anterior limb of the tympanic in mammals, and meets the malleus. This difference seems to be due to changes in proportions of the region of the old reptilian jaw articulation, and to slight lateral movement (relative to the articulation) of the 'reptilian' tympanum and external auditory meatus, during the transition to mammals. The latter is distinctly indicated by the

position of the groove for the meatus on the posterior face of the squamosal in many therapsids.

Such changes would bring the 'reptilian' tympanic membrane over the back of the articular. This also fits well into the scheme of regional plastic changes in the skull during the therapsid-mammal transition previously described[6]. It is probable that the processus lateralis of the malleus is a relic of an earlier attachment of a tympanic membrane on the articular —probably of the old reptilian tympanum at a stage when the dentalo-squamosal articulation had become the adult jaw articulation, so that the articular was relatively immobile.

The *Chordafalten* would then seem to be the reduced and compressed equivalent of the tissues which laterally separated the upper part of the tympanic cavity of therapsids from the recessus mandibularis. Their relations to the chorda tympani, to the malleus and goniale, to the tensor tympani and to the enlarged tympanic annulus, can readily be understood in this way (cf. Figs 1–3). It should be noted that a compressed posterior *Chordafalte* would not result if a depressor mandibulæ muscle of ordinary reptilian ('sauropsid') type were present. But in the higher therapsids the 'loose' quadrate and the delicately built articular region make it clear that the jaw musculature cannot have been closely comparable with that in, for example, lizards. It seems probable that at least some of the more mammal-like reptiles had already some 'mammalian' characters in the muscles for opening the jaws. In monotremes this is done by the detrahens mandibulæ (a slip from the adductor externus group), while other mammals have developed a digastric (from the intermandibularis and interhyoideus musculature) This supports the suggestion that mammals are not monophyletic. Parallel evolution in higher therapsids is well known, and in many structures the trend is towards a mammalian pattern ; Olson[7] has recently demonstrated several new and striking trends. If more than one therapsid stock gave rise to mammals, the great similarity in the tympanic membrane and related structures in all mammals suggests either a further example of very closely parallel evolution, or that, in at least some therapsids, the outer membranous wall of the recessus mandibularis had already assumed some kind of tympanic function.

The therapsid and sauropsid reptiles differ in so many ways that any advance in understanding of these problems can come only from palæontological evidence combined with a study of the anatomy (particularly developmental) of generalized mammals.

Finally, it should be noted that the accessory 'dermal' elements associated with the malleus may not be correctly homologized within the group. The ossiculum accessorium malleoli and the goniale need the most careful re-investigation, but their relations in *Chrysochloris* in particular support the tentative homologies previously suggested[1].

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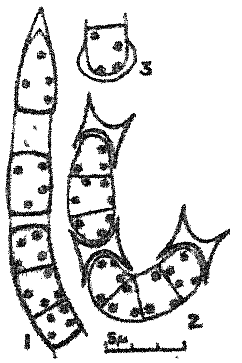
New Observations on *Uronema*

Uronema indicum growing as an epiphyte on aquatic plants in July at Allahabad, India, has been studied in natural as well as cultural conditions. In Nature the filaments were about 6 mm long, but in culture they attained a length of 4·2 cm. The cells showed wide variations, even in Nature. Usually they were 14–19 μ long and 6–14 μ broad and had a chloroplast occupying the whole length of the cell In many cases the cells, especially those near the tip, were much longer (40 3 μ) and had the chloroplast only in the middle The size of the filament and cells and the extent of the chloroplast within the cell have been made the chief features for differentiating the various species of Uronema. The above observations show that such variations may also be due to ecological conditions



No method by which *Uronema* perennates has so far been reported. This species was found to perennate by means of akinetes under both natural and cultural conditions. The akinetes were formed in Nature on desiccation or on approach of winter and in culture due to overcrowding or growth in continuous strong light. The akinetes had only a slightly thick ned wall and were single or more usually composed of a row of cells (Fig. 1). When put in tap water, even after three months the cells of the akinete (from both Nature and culture) began to elongate, thereby rupturing the wall which for a time remained attached to the end as H-pieces (Fig. 2). The terminal cell gradually became acuminate and the basal cell acquired a hyaline mucous pad for attachment (Fig. 3) Further growth and cell division resulted in a long filament

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Origin of Viruses

IN recent times two abnormalities have arisen in the apple Lord Lambourne when this variety has been grafted on to certain other kinds. (1) where the branches and growth lack rigidity, so that the weight of even a few fruits pulls the branches almost vertically to the ground, (2) where the fruit only develops about a quarter of normal size. Thus when Lambourne has been grafted on to the variety Excelsior, Lambourne has developed non-rigid growth, and when grafted on to Redcoat Grieve it has developed the small-fruit abnormality. The same reactions have occurred in Lambourne when it has been grafted on to certain other kinds.

The behaviour of the abnormalities[1] suggests they are of the nature of viruses and that they have arisen directly by grafting, that is to say, by the invasion of the cells of one variety by the proteins of another. In some cases where the abnormalities have arisen three individuals have been grafted

together, therefore the possibility of all three taking part in the origin of the abnormalities cannot be ruled out.

Recently, Darlington[2] has recalled the work of Salaman and Le Pelley[3], who found the potato King Edward when grafted on to other varieties produces disease, and it seems probable that the Lord Lambourne abnormalities are of the same kind. These cases differ, however, in one respect. For in the potato, King Edward introduces something into the varieties with which it is grafted which is deleterious to them, whereas in the apple it is Lord Lambourne which alone has, so far, suffered from combinations with different varieties or stocks

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Fluorescence in Ultra-Violet Light as a Test for the Presence of Leaf Roll Virus in Potato Tubers

ON reading an article in the *School Science Review*[1], I recently became interested in the use of ultra-violet light as a possible means of detecting the virus responsible for potato leaf roll in the tubers of the plant.

Tubers were collected (including 'setts' where possible) from leaf rolled plants during late July and early August, and at the same time tubers were taken from healthy plants of the same varieties. After being cleaned they were examined under ultra-violet light from a 230 v. 125 amp. 3-pin base bulb fitted with a Wood's glass filter supplied, through Mr. Brennan, representative of the General Electric Co. in Belfast. Since no fluorescence was observed from the entire tubers—they assumed a light mauve colour, with the 'eyes' showing up as white areas—they were then cut transversely. The cut surfaces of the tubers from the leaf rolled plants then displayed varying amounts of fluorescence. This fluorescence was most marked in the 'setts', where it appeared to extend throughout the medulla (pith), but was more limited in its distribution in tubers of the present season's growth, where it appeared to be confined to the vascular bundles.

In comparison, cut tubers from healthy plants showed a much lighter colour on the cut surfaces than on the 'skin', but there was no sign of fluorescence—merely a lighter shade of the mauve colour referred to above.

Although the number of tubers examined was small, there appears to be every possibility that this test could be used with some degree of certainty in diagnosing the presence of the leaf roll virus in potato tubers, and the test has the advantage of being rapid. The cutting of the tubers can be carried out near the 'heel' end, and damage to the buds in the 'eyes' easily avoided.

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Wood-boring Insects in Beech Furniture

IN Mr. A. L. Howard's recent article[1] on "The Beech Tree" it is stated that "beech has been a favourite wood with chair-makers for 200 years and perhaps more. The higher class makers . . . generally used beech for the frame. . Many fine specimens of artistic design and clever craftsmanship have been lost, as the beech framework used was attacked by the *Lyctus* or *Xestobium* beetles, or both, the framework rapidly turning to dust, and the chairs breaking up."

Records of infestation of timbers by these insects have, however, shown that neither normally occurs in beech furniture *Lyctus* powder-post beetles (family Lyctidæ) attack partly and recently seasoned sapwood of certain hardwoods such as oak, ash, elm walnut, in which the vessel diameter is sufficient to accommodate the ovipositor of the female and in which the starch content of the wood is adequate for the nutrition of the larvæ. Neither of these conditions is fully fulfilled by beech, which is not liable to infestation by these insects.

Beech is not immune to attack by *Xestobium rufovillosum*, the death-watch beetle (family Anobiidæ); but this insect rarely occurs in furniture, although well known for its powers of destruction in roofing and other structural timbers, chiefly oak, when conditions are favourable for its development

There are two insects, both belonging to the family Anobiidæ, which sometimes do cause serious damage to beech timber: the common furniture beetle (*Anobium punctatum*), the most frequent cause of 'worm' in old furniture, not only of beech but also of many other woods, including walnut; and, less commonly, *Ptilinus pectinicornis*, which also occurs in sycamore and willow. Of these, the common furniture beetle is by far the more important, and in the course of repairs to valuable furniture such as that mentioned by Mr. Howard, the use of a suitable preservative treatment for woods susceptible to attack by this insect is advisable to prevent a recurrence of the trouble

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Newton and His Portraits

I WRITE with reference to the note in *Nature* of January 13, on portraits of Newton. We have in this College a portrait of Newton painted by Henry Cooke in 1669, the year in which he became Lucasian professor. Newton was a benefactor of St. Catharine's College, lending money to erect the new buildings at that period, a loan which he later made a gift. We have no record of the circumstances in which the portrait was painted, but it shows him as a young man in a red gown with the open neck typical of his later portrait by Kneller.

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RESEARCH ITEMS

Myohæmoglobin and the Crush Syndrome

A COMMON type of air-raid casualty is the person who has remained trapped for several hours with a limb crushed or compressed beneath debris. Such patients, after their release and admission to hospital, frequently develop a characteristic set of symptoms which has been called the 'crush syndrome'. The most striking features of this condition, apart from surgical shock, are the excretion of myohæmoglobin in the urine and the onset of severe renal failure, which often ends in death from uræmia. Bywaters and Popjak (*Surg. Gynec. Obst.*, 75, 612; 1942) attempted to reproduce this condition in rabbits by experimental crushing or compression of the leg muscles. They found that surgical shock ensued as in man, but there was no myohæmoglobinuria and no renal damage. The absence of myohæmoglobinuria was readily explained by the finding that rabbit's muscles contain practically no myohæmoglobin, and the results naturally suggested that the renal damage which occurs in man might in some way be caused by the renal excretion of myohæmoglobin. Bywaters and Stead (*Quart. J. Exp. Physiol.*, 33, 53; 1944) have investigated this possibility and they find that while injection of myohæmoglobin into normal rabbits (with alkaline urine) does not damage the kidney, injection into rabbits with acid urine or into rabbits after limb crushing does produce severe kidney damage which may be fatal. It seems that in the crush syndrome both myohæmoglobin and various acid breakdown-products are liberated from the crushed muscle, and the excretion of myohæmoglobin in an acid urine is the main cause of the renal damage, though why myohæmoglobin should damage the kidney is not yet clear.

Pancreatic Extracts and Cell Growth *in vitro*

J. N. Davidson and C. Waymouth (*Quart. J. Exp. Physiol.*, 33, 19; 1944) have shown that a simple extract of pancreas (pancreatin) contains substances which influence the growth of chick heart fibroblasts *in vitro*. Two factors have so far been separated and they have been partially purified, but not completely so. One factor, which the authors consider may be lecithinase A, has a striking effect on the morphology of the cells in culture. Normal fibroblast cultures nourished with embryo extract present the appearance of a loose network of elongated cells with oval nuclei; under the influence of this pancreatic factor the appearance alters to one of closely packed polygonal cells with round nuclei. The second factor stimulates growth of the culture (as judged by the increase of nucleoprotein phosphorus), and its action seems to be similar to that of embryo extract. This factor probably comprises polypeptides and certain breakdown products of nucleic acids, substances which may well serve as raw materials for nucleoprotein synthesis. Trypsin and ribonuclease, though present in the crude extract, were absent from the fractions finally employed, and are therefore excluded.

Lower Jaw of Stegocephalia

THE Stegocephalia are generally regarded as the amphibian order that most nearly approaches the stem of the Reptilia, and consequently in them one is most likely to find morphological relationships that will help in understanding the conditions met with in reptiles. A comprehensive and comparative account of the lower jaw of the Stegocephalia is furnished by T. Nilsson (*Kungl. Svenska Vetensk. Akad. Hand.*, 21; 1944). The following homologies are suggested: the bone up to now regarded as the 'splenial' of the Stegocephalians is termed the presplenial, while that in the reptiles is probably the fusion of pre- and post-splenials; the posterior meckelian foramen is the posterior mylohyoid, the anterior meckelian is the anterior mylohyoid and the post-symphysial foramen is the lingual foramen of reptiles. Owing to the considerable amount of overlapping in the dermal bones their superficial outlines do not indicate accurately their extension at deeper levels. The foramina and canals in the bones of the jaw allow of an attempt at a restoration of the nerves and blood vessels, and on this certain new names of general application are proposed for them. In considering the veins it is suggested that there were in the head of the Stegocephalian a series of sinuses similar to those in many living reptiles and that these served for the exuviation of the head and possibly to frighten enemies.

Scottish Cephalopods

FOR a number of years the Fishery Board for Scotland collected marine fauna over the Scottish area, using this term in a wide sense, and the Cephalopoda in this collection, together with those of the Royal Scottish Museum, Millport Marine Biological Station and the University of Glasgow, form the basis for an account of this group by A. C. Stephen (*Trans. Roy. Soc. Edin.*, 61, Pt. 1; 1944). In all, 47 species and one variety are dealt with, but some of these are not strictly Scottish although, occurring in adjacent waters, they might be found within the narrower limits at any time. None of them is a new species; but our knowledge of the areas of distribution of some of them has been considerably extended. There is evidence to show that an increase in the flow of the North Atlantic Drift has been responsible for the immigration of several forms in comparatively recent years. These species are mainly southern forms like *Ommatostrephes sagittatus* and *Stenoteuthis caroli*; on the other hand, *Rossia glaucopsis*, a northern form, appears to have become more rare.

Termites of New Zealand

J. M. KELSEY has given (*N.Z. J. Sci. and Tech.*, May 1944) an account of the termites known from New Zealand and their identification. It appears that there are only two species indigenous to the Dominion, namely, *Calotermes brouni* Frogg. and *Stolotermes ruficeps* Brauer. In addition to these, there are eight species of Australian termites that have been accidentally introduced at one time or another. Of the native species, *C. brouni* does extensive damage to wooden buildings, posts, poles and trees. Attempts are now being made to find an effective means for its control. The other species, namely, *S. ruficeps*, is invariably found in decaying timber and has not so far been found attacking buildings. Of the Australian species, three kinds belong to the family Rhinotermitidæ and are members of the genus *Coptotermes*. Four species are members of the Calotermidæ, and of these three belong to the genus *Calotermes* and one to *Porotermes*. The Termitidæ are represented by a single species of *Eutermes*. The paper gives detailed descriptions of the eight species referred to above, together with illustrations of the chief distinguishing characters that separate them.

Golgi Bodies

REALIZING that much of the extensive work that has been done on the Golgi elements is based upon empirical procedures because of the lack of knowledge of their chemical nature and composition, Dr J. R. Baker (*Quart J. Micro Sci.*, 85, Pt. 1 ; 1944) has tackled the problem of their structure from a new point of view. For the purpose of this study the author took the spermatocytes and early spermatids of the snail *Helix aspersa*, intestinal cells from the newt *Triturus vulgaris* and cells from the anterior mesenteric ganglion of the rabbit *Oryctolagus cuniculus*. which he considered gave him a wide enough range of animals and tissues to allow generalizing. Structurally, it was found that the Golgi element consists of four parts, the 'neutral red vacuoles', a dense lipoid containing substance in various shapes, a diffuse lipoid-containing substance filling in the interstices and a Golgi product which arises in the vacuole by synthesis by the element. The first part of the paper consists of a description of the structures found, checked up where possible against the structures visible in the living cell. The second part is an account of the chemical nature of the structures and their reactions to various techniques.

Sex Determination in *Habrobracon*

P. W. WHITING (*J. Hered.*, 34, 355 ; 1943) has summarized the recent data on sex determination in the parasitic wasp *Habrobracon*. Formerly it was believed that the female was XY and the male haploid X or Y, or diploid XX or YY in respect to the sex determiners. It is now shown that sex determination is controlled by a series of multiple allelomorphs in such a way that the heterozygotes are female, and the haploids and homozygotes are male. Some rather novel results are obtained consequently in sex linkage and in the nature and occurrence of sex mosaics. Haploid mosaic males appear at a frequency between 1 in 500 and 1 in 5,000 in the progeny of heterozygous females. They arise from binucleate eggs. In a few cases trinucleate eggs must have been involved. Also females have arisen without fertilization as a result of doubling of the chromosome number in the oogonia. Dispermy is relatively frequent, but the expected androgenesis is rare. The sex reactions of the insect were known to be associated with the head, but it is now known that an insect with female eyes and male antennæ reacts as a female, thus limiting considerably the tissues which are associated with sex reactions.

Plant Growth Substances

THE relation between molecular configuration and activity of plant growth substances or auxins has yet to be elucidated ; but V. T. Stoutemeyer (*Proc. Amer. Soc. Hort. Sci.*, 42, 365 ; 1943) reports that the addition of methyl, hydrogen and isoprene groups at various positions on naphthalene acetic acid does not reduce its root-forming properties. The addition of the isoprene group in some cases actually increased activity, while tetrahydronaphthalene acetic acid usually caused the production of a greater weight of roots per cutting (without increasing the number of cuttings rooted) than the unreduced acid. The same worker later reports that while naphthalene butyric acid is as effective as (and less toxic than) the corresponding acetic acid, and the isoprene ester of the naphthalene butyric acid is still more effective, α-naphthalene α-propionic and α-naphthalene β-propionic acid were both less effective than α-naphthalene acetic acid.

Effect of Methyl Cellulose on Water-loss in Plants

IN a short note, I M. Feller and V. R Gardner (*Proc. Amer Soc. Hort. Sci.*, 43, 183 , 1943) describe an experiment, the results of which may have far-reaching consequences. They show that the addition of a 1 per cent or 2 per cent aqueous suspension of methyl cellulose to bare soil or to soil in which plants were growing in a greenhouse reduced water loss from both soil and plant by as much as 50 per cent without exerting any observable harmful effects on the plants. Initial treatment remained effective for three months. If further experiments show that repeated treatments have no harmful effects on the soil and on plant growth, these experiments may prove to be of prime importance in at least a limited field of horticulture.

Polythene as a High-Frequency Dielectric

Prof. Willis Jackson and Mr. J S A. Forsyth recently read a paper on this subject in London before the Institution of Electrical Engineers. The paper is mainly concerned with the power factor of polythene which, being normally of the order of 0·00015–0·0003. renders the material very suitable as a high-frequency dielectric. Oxidation may occur, however, during the processing of the material in the manufacture of cables and mouldings ; this increases the power factor and leads also to difficulties in extrusion. These effects may be virtually eliminated by the use of small amounts of antioxidants. The measurable power factor of pure polythene is scarcely concordant with the supposedly non-polar nature of the substance, and a number of possible explanations of the small basic power factor have been investigated. Measurements of power factor over wide frequency and temperature ranges show that its variation for pure polythene is extremely sluggish, but that oxidation causes the appearance of marked peaks ; these observations are examined in the light of present theories of dipole loss. A brief account is given of the structure of polythene, and of its main physical and mechanical properties.

Observations of Eros at the Cape Observatory

A PAPER on observations of Eros during 1938 and 1942, communicated by H M. Astronomer at the Cape (*Mon. Not. Roy. Astro. Soc.*, 104, 3 , 1944), includes a short description of the instruments used and of the method of reduction of the plates, etc. In 1938 the observations were made with the astrographic telescope west of the pier. In 1942 the first two or three exposures were generally made with the telescope west of the pier before Eros reached the meridian, then observations were made with the Victoria telescope near the meridian. Finally, the astrographic telescope was reversed and several exposures were made with the telescope east of the pier. The same plate was used for the two sets of exposures with the astrographic telescope and hence the mean of the two sets should eliminate any displacement due to tilt of the plate. The plates during 1938 were taken by Dr. R. H. Stoy, and in 1942 they were generally taken by Dr. J. Jackson. Tables with the results of the observations in the two years are given ; but for 1938 the observed positions only are given, corrected for parallax and referred to the equinox of 1938·0. For 1942 an ephemeris by Stracke was available, and for comparison with this ephemeris it is only necessary to subtract the light-time from the time of observation, corrections for parallax and aberration having been applied to the positions given.

EPIDEMIOLOGY OF BARTONELLOSIS

IF any biologist requires a problem which will exercise to the full his patience and experimental skill, he could get it from the monograph "Infectious Anæmias due to Bartonella and Related Red Cell Parasites", by David Weinman (*Trans. Amer. Phil. Soc.*, Philadelphia, New Series, 33, Part 3, 243–350; 1944). Weinman was parasitologist to the Harvard Expedition to Peru in 1937, which finally established the fact that *Bartonella bacilliformis* is the cause of both Oroya fever and Verruga peruviana (Verruca peruviana, Verruga peruana), both of which are sometimes called Carrión's disease. Carrión, one of the pioneers of the study of these South American diseases, died of Oroya fever after inoculating himself with verruga material.

As Prof. Tyzzer says in his preface to this monograph, the symptoms of these two diseases are so different that it is not surprising that they were, until comparatively recently, considered to be due to different organisms. The main symptoms of Oroya fever are fever, marked pain in the head, joints and bones and a rapidly developing anæmia. If the patient does not die in a few weeks, a verrucous stage may follow. The mortality is 40 per cent or higher. Verruga peruviana is a milder infectious disease in which superficial and deep nodules appear. The superficial ones resemble warts and are about the size and colour of cranberries when they are mature; the subcutaneous ones are larger, less numerous and often erode the skin surface. These eruptions last from one to twelve months and then disappear. Mortality is low Latent infections with *Bartonella bacilliformis* may occur without symptoms. It is now known that both diseases are due to the single species of *Bartonella—Bartonella bacilliformis*—which was formerly classed among the Protozoa, but is now classified by Tyzzer, Weinman and others as a flagellated bacillus.

The two diseases caused by this organism are both confined, at present, to a restricted area of South America, namely, to a narrow strip of the Andes in Peru to foci in the south-west of Ecuador and to the neighbourhood of the city of Pasto in Colombia. Central American foci in Honduras and Guatemala have been suspected, but have not been proved. Weinman points out, however, that human bartonellosis appears to be spreading in its epidemic form. In animals the related genera *Hæmobartonella* and *Eperythrozoon*, which have been, for reasons discussed by Weinman in this monograph, removed from the genus *Bartonella*, are widely distributed and may be present in laboratory animals used for studies of the blood or reticulo-endothelial system or for nutritional and other problems; they may profoundly affect the results of these studies. The comparative study of animal bartonellosis may, Weinman thinks, illuminate the etiology, pathogenesis and treatment of blood diseases. This study has already revealed that the spleen has an important immunological function in animals infected with *Bartonella*. It maintains an equilibrium between certain of these parasites and their hosts, which is so perfect that infection may never be apparent unless splenectomy is performed; and the study of this function of the spleen may give us new information about the relation of the spleen to immunity. We are here reminded of the work of J. E. Larsh, jun. (*Amer. J. Hyg.*, 39, 133; 1944; and *Trop. Dis. Bull.*, 41, 765; 1944) on the increased susceptibility of mice not infected with Bartonella to infestations with the cestode *Hymenolepis nana* var *fraterna*, when the whole spleen (that is, a large part of the reticulo-endothelial system) is removed

Historically the cutaneous form of human bartonellosis, Verruga peruviana (Verruga peruana), was known to the pre-Inca inhabitants of Peru. Among the illustrations of operations and diseases found on ancient pottery ('huacos') "pertaining to the Chimu civilization", Verruga peruviana has been identified. When the Spaniards arrived, they found that Verruga peruviana was already distinguished in the Keshua language from the common wart and other diseases, and the very first group of conquering Spaniards suffered from it. Less appears to be known about the history of the anæmic form of human bartonellosis (Oroya fever). A serious epidemic of it in 1870 in workers building a railway from Lima to Oroya caused 7,000 deaths, and this and later epidemics led to the popular saying that "every crosstie in the railroad represented a human life". The nature of Oroya fever was not clearly known until Carrión, who was dissatisfied with the existing knowledge of Verruga peruviana, decided to inoculate himself with verruga material. He developed Oroya fever and died of it on October 5, 1885. It was not until 1905 that Barton described bodies in the blood which were, he claimed, living organisms and the cause of Oroya fever. His claims were not accepted until the 1913 Harvard Expedition to Peru confirmed Barton's findings and gave the name *Bartonella bacilliformis* to the bodies which he had described. This Expedition made great contributions to our knowledge of the disease. But its etiology remained obscure until Noguchi and Battistini cultivated *B. bacilliformis*. The 1937 Harvard Expedition to Peru finally established the fact that *B. bacilliformis* causes both Oroya fever and Verruga peruviana.

B. bacilliformis is extremely polymorphous, and its taxonomy, microscopical appearance, cultivation and behaviour in experimental animals are fully described by Weinman. The symptoms of the various forms of the two diseases which it causes are also described in detail. The section on epidemiology and transmission by sandflies is valuable. *Phlebotomus verrucarum* seems to be the most important vector of the three species of *Phlebotomus* occurring in those areas of Peru in which bartonellosis is endemic (*P. verrucarum*, *P. noguchii*, *P. peruensis*). The four other Peruvian species of *Phlebotomus* have not yet been incriminated; and no other blood-sucking arthropod has been shown to be naturally infected with *Bartonella*. Infection by contact does not occur in ordinary circumstances. The disease has, however, been reported as a new one in Colombia since 1935, and none of the Peruvian sandflies has yet been collected in Colombia. This suggests that *B. bacilliformis* was introduced into Colombia and then became established in the Colombian sandflies, rather than that Peruvian infected sandflies became acclimatized in Colombia (as, for example, African *Anopheles gambiæ* became established in Brazil in 1939 and caused there one of the most devastating epidemics of malaria known to history (see *Nature*, 153, 765; May 20, 1944)). If this is so, the question arises whether other species of *Phlebotomus* could become vectors of *B. bacilliformis*. This question has not been studied experimentally. It is important, because sandflies which bite man are widely distributed throughout the world in tropical and temperate countries (cf. the part they play in transmitting to

man the cause of human cutaneous leishmaniasis (*Leishmania tropica*) in the Gerbils and Sousliks of the deserts of middle Asia, described in a review of Russian work on this question by C. A. Hoare (*Trop. Dis. Bull.*, 41, 331 : 1944)) Modern rapid methods of transport could either carry the sandflies which transmit *Bartonella* or infected human beings to an area inhabited by uninfected sandflies.

Two alleged cases of congenital transmission of *Bartonella* in man are reported by Weinman, and the factors affecting susceptibility and resistance to the infection are discussed. Man is the only important known source of *B. bacilliformis*, and *Phlebotomus* the only other animal known to be naturally infected. There is, however, some evidence that dogs may be naturally infected sometimes The suggestion that domestic animals, lizards, rats and some plants may be reservoirs of the infection has not been confirmed Weinman discusses at length the immunology, treatment and control of the infection, but these complex questions cannot be discussed here. Treatment of Oroya fever is the most important, because of its high mortality, but the study of it is handicapped by our inability to produce the syndrome at will in experimental animals.

In Chapter 2 Weinman discusses the genus *Hæmobartonella*, created by Tyzzer and Weinman in 1939, to include *Bartonella*-like organisms which do not multiply outside the blood and do not produce skin eruptions, whereas human *B. bacilliformis* develops in fixed tissue cells and causes skin eruptions. *H. muris*, the type species, is a widely distributed parasite of the albino rat, in which it exists as a latent infection and causes anæmia. It is transmitted by rat lice and fleas. It is infectious for albino mice, the rabbit and some other rodents It can be eradicated by neoarsphenamine and other organic arsenicals. Weinman describes fully the other species, of which twenty-one have been named. Those most clearly established are in albino rats and mice and some other rodents, in voles, guinea pigs, oxen, buffalo and dogs. Other forms of *Hæmobartonella* not of specific rank have been found in the wild rat, dormouse, opossum, hamster, deermouse and squirrel. Organisms having some resemblance to *Hæmobartonella* have been recorded from the bat, monkey, ant-eater, rat and dormouse and from the tortoise, frog, lizard, gecko, lamprey, tench and pike.

Chapter 3 deals with *Eperythrozoon*. Species of this genus are blood parasites with some resemblance to *Bartonella* and *Hæmobartonella*, and they cause anæmia in various vertebrates. The infection, which at first causes symptoms, becomes latent, and removal of the spleen causes relapses. These organisms have not yet been cultivated *in vitro*, but animals can be infected by inoculation of infected blood. Their transmission by arthropods is known and they respond to therapy with organic arsenicals, so that they are regarded as being living organisms. They occur in white mice (*E. coccoides*, transmitted by the louse, *Polyplax serrata*, and possibly by other means); in dwarf mice and voles (*E. dispar*); in sheep (*E. ovis*, the method of transmission is not known) and in cattle (*E. wenyoni*, the method of transmission is not known). Other so-called species require confirmation. The single case in which infection of man (a child) with *Eperythrozoon* was suspected is discussed by Weinman.

Chapter 4 discusses the public health aspects of bartonellosis. Its importance is shown by the fact that although the epidemic of 1870 in Peru involved a very small region, some 7,000 people died, and in Colombia more recently 4,000 deaths have been attributed to bartonellosis in one year (1938). The disease is, so far as we know, restricted to Peru, Colombia and Ecuador, and is irregularly distributed in a long, narrow area of the Andes, 1,000 miles long by about 100 miles wide, in which it occurs at moderate altitudes, near water and most often in narrow valleys; but it is probable that its distribution is incompletely known.

Man is both the victim and reservoir of *Bartonella bacilliformis* and no other animal naturally infected with this species is known, except the sandfly vector. Weinman discusses fully the epidemiological evidence for this Further knowledge of the insect vector is required, because most of our knowledge about it has been worked out in Peru only. The nocturnal biting activity of the sandfly explains why the disease is chiefly contracted at night, and this biological fact has been used for control. Workmen repairing a railway bridge over the Rimac River were, for example, removed by train from the bridge in time to be outside the endemic zone before nightfall. *Phlebotomus*-proof buildings would be equally effective, and when Shannon lived for months in one of these in an endemic area, he did not become infected; but the expense of providing them for everyone would be great. Repellents applied to the body and insecticides are said to help protection. Other measures aim at reduction of the numbers of the sandflies by destruction of the day-time hiding places of the adults in dark places; but lack of knowledge of the biology of the immature stages handicaps this kind of control The adults are not vigorous fliers and probably do not get very far from the places where they emerge. The fact that endemic foci of the disease are bounded by upper and lower limits of altitude, which are often quite sharply defined, requires further explanation.

G. LAPAGE.

SCIENTIFIC AND INDUSTRIAL RESEARCH IN NEW ZEALAND

THE eighteenth annual report of the Department of Scientific and Industrial Research, New Zealand, covering the year 1943–44, includes the Minister's statement, the Secretary's report, reports of the research committees of the Council, and on research work at the Canterbury and Massey Agricultural Colleges, as well as on the Dominion Laboratory, Observatory, Physical Laboratory, Magnetic Observatory, Geological Survey and Meteorological Branch.

Under the Building Research Committee, investigations have been continued by the Entomology Division of the Plant Research Bureau into the biology of the two native termites, and in co-operation with the Plant Diseases Division investigations were undertaken into the biology of *Anodium punctatum*, including the factors controlling oviposition and the influence of seasoning of both kiln- and air-dried sapwood against attack, with the view of securing data on the best method of treating various timbers as a protection against borer attack. The State Advances Corporation has continued its work on field investigations of timber-infesting insects and fungi, and field application of termite control and on

wood preservatives. A special committee was set up to deal with the problem of mould growth on the linings of houses; the report of the Plant Diseases Division shows that mould growth can be controlled by applying a 2 per cent solution of the sodium salt of pentachlorophenol to the materials used in finishing the wall surfaces. The Auckland Building Research Panel has investigated the behaviour under stress of a floor consisting of pre-cast reinforced concrete joists and slabs.

The Dairy Research Institute has again limited its research to projects concerned with the New Zealand war effort, but has continued to give advice and assistance with the commercial manufacture of dry butter-fat by the method developed at the Institute. Work on land cress taint in cream and butter has clearly indicated that the benzyl *iso*thiocyanate present in land cress is not the cause of the peculiar taint in the butter from cows consuming it, as garden cress contains the same glycoside. Principles laid down in the previous year for the protection of starter culture from infection with bacteriophage have proved sound, and many isolated starter rooms have been built during the year at commercial cheese factories. Continued experience has shown that single-strain starter cultures can be maintained free from infection over long periods where isolation together with aseptic handling is practised. A tentative start has been made on an investigation into the possible use of phage as a cure for mastitis in dairy cows. Some progress has been made in the field towards a cure for 'mechanical' openness in cheese. Hormone studies have covered milk secretion in dairy cattle and parturition in pigs.

Under the Food Preservation and Transport Advisory Committee, development work has continued on dehydrated meat, including the increase of the fat content to 40 per cent by addition of edible rendered tallow, and the installation of plant for the re-addition of the concentrated cooking juices to improve flavour and compatibility, and for packaging the dried meat under compression in accordance with specifications of the United Kingdom Ministry of Food. Commercial manufacture of dehydrated vegetables began at the end of March 1943, in a tunnel dehydrator of the Eidt type designed by the Chemical Engineering Section of the Dominion Laboratory; the plant has given performance and quality fully up to expectation. Dehydration of apples on behalf of the Internal Marketing Division has now reached the production stage. Fruit cold-storage research has included the refrigerated gas storage of apples, superficial scald on Granny Smith apples, the effect of fertilizers at the root on cold-storage quality and the control of wilt in cold-stored pears and apples. Under the Fruit Research Advisory Committee, long-term manurial investigations and root-stock trials on apples have continued and other work has covered stone fruit and citrus. Research at the Cawthron Institute has covered the magnesium deficiency of apples, distribution of magnesium and potassium in leader growth and apple-juice concentrates.

In the Industrial Psychology Division established towards the end of 1942, investigations have been in progress on absenteeism in forty-six factories in the four main centres of the Dominion, on the ventilation and heating of factory buildings, and on the reduction of fatigue and monotony, especially the effect of factory seating. The Division has also been responsible for the issue of a quarterly bulletin, lectures and addresses, service work for manufacturing concerns, co-operation with the Government Vocational Guidance Centres and work for the Armed Services. Under the Leather and Shoe Research Advisory Committee, the Leather Research Association has continued its work on the formulation of standards for sole leather, the flexibility of sole leather and a field trial to determine whether any relation could be established between wet rigidity and actual wearing value. The Shoe Research Association has investigated the effect of the method of construction on the flexibility of the shoe with the object of linking the work up with that on the flexibility of sole leather. Pelt research is yielding concrete results due to the institution of chemical controls in the process and the checking of the curing process in the finished pickled pelts.

Investigations at the Cawthron Institute on the mineral content of pasture have covered the effectiveness of application of cobalt sulphate in field trials. Under the Mineral Resources Committee, the prospecting and boring of the Clarendon phosphate deposits has been directed, and the results of the quantitative surveys of the Chatham Island peat wax deposits, with chemical work at the Dominion Laboratory and the Imperial Institute, have been published.

The New Zealand Wool Manufacturers' Research Association has continued its work on improvements to the wet chlorination process of rendering woollen fabrics resistant to shrinkage. The Plant Chemistry Laboratory has continued its research on the suitability of different varieties of vegetables for dehydration, and satisfactory results have now been obtained in dehydrating peas and beans. Under the Plant Research Bureau, work on linen flax has included the production of pure seed and weed control, and the Botany Division has also continued weed investigations, work on fibre plants and on medicinal plants. Investigations on the Russian dandelion indicate that a solution of the difficulties involved in direct sowing is crucial to development. The Entomology Division has continued its survey of the diamond-back moth, cocksfoot stem-borer, and cheese-mites, and has found that dichloroethyl ether is highly toxic to the common cheese-mite, even at very low concentrations. The Grasslands Division has maintained its plant-breeding programme with perennial rye grass, Italian rye grass, short-rotation rye grass, Western Wolths rye grass, cocksfoot, timothy, white clover and red clover, and there has been no slackening of the work on aerodrome grassing and turf. Work on green-keeping research has continued, and plant disease investigations under the Plant Diseases Division have covered linen flax diseases, legume diseases, vegetable diseases and diseases of medicinal plants. The Soil Survey Division has devoted attention to soil fertility problems and produced maps showing where this is being reduced through erosion. Tobacco research has included fertilizer experiments, investigations on mosaic and other tobacco diseases, seed production and plant breeding, the chemistry of curing and recovery of nicotine from waste tobacco. Research work at the Canterbury Agricultural College has included sheep-dipping experiments, investigations on insect pests of wheat crops, and wool survey by the Wool Metrological Laboratory; while at the Massey Agricultural College sheep-nutrition experiments, drainage research work and work on sheep-breeding methods and pig research have been in

progress. Root development work, which has now been suspended, is reviewed in the report.

In addition to testing work the Dominion Laboratory has been concerned with research work, the Chemical Engineering Section being largely occupied with work connected with the dehydration of vegetables and apples, while the Physical Chemistry Section has been concerned mainly with spectrographic analysis. The Coal Survey Laboratory has continued its physical and chemical survey of the coal resources of the Dominion Many investigations on paints and protective coatings have been carried out during the year both for defence and civilian purposes. Rubber problems investigated during the year included particle-size and other determinations of rubber fillers, preparation of rubber solutions, investigation of rubber tyre preservatives, rubberware for milking machines, and an examination of the possibility of manufacturing synthetic rubber in New Zealand. At the Dominion Physical Laboratory, the physical testing and electrical laboratory was concerned with the yield and quality of linen flax fibre, dimensional changes of trace line paper for map reproduction, mould on inner wall surfaces in New Zealand houses and the application of radioactive luminous paint for equipment.

At the Magnetic Observatory, Christchurch, the programme of work in terrestrial magnetism, seismology, cosmic radiation, atmospheric electricity and meteorology was generally maintained during the year.

BATS

By OLIVER G. PIKE

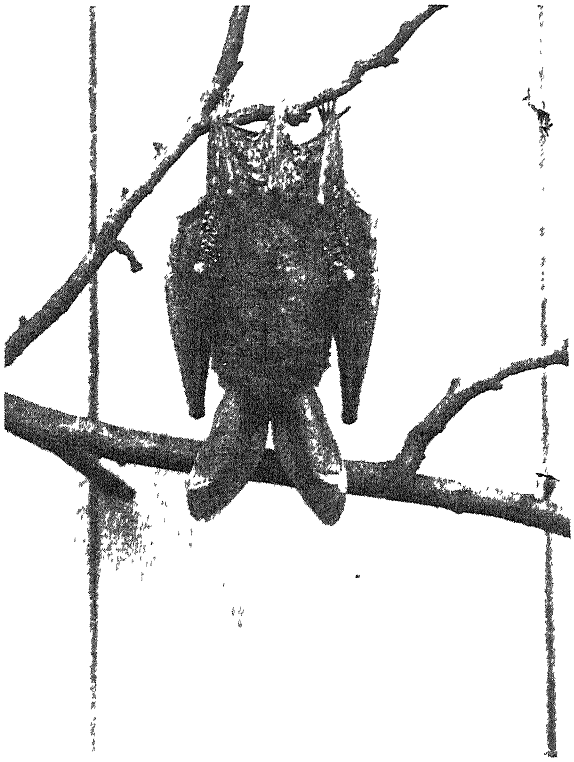
THERE are very few naturalists who can with certainty distinguish British bats in flight. It even comes as a surprise to many to learn that there are twelve species in Great Britain. The chief reason British bats have been so neglected is that they appear, except at rare intervals, at dusk and before dawn, and are therefore very difficult to observe. Apart from this, they live, as a rule, in rather inaccessible places, and most of their daylight haunts are dark.

When watching a bat on the wing, we are looking upon the most perfect example of flight. I do not know any bird that can equal their powers of manœuvring ; a bat going full speed (and it can travel fast) will suddenly stop, do a quick right or left turn, rise and dive, turn completely over, and perform other stunts that are bewildering to watch.

To many, bats are mammals without a voice. This is because the high-pitched cry, which is very frequently uttered while flying, is beyond the powers of hearing of about three out of every four people, while the low, loud noises, such as the beating of a large gong, make no impression on them.

Bats are flying mammals ; through the millions of years of evolution their arms have changed into wings. If we examine the wing of a bat, we see how the bones are really exaggerated fingers, with a thin flexible skin stretched over them, while on the bone that corresponds with our thumb there is a hook, which the animal uses to attach itself to some support while resting.

All bats have one young only during the year, which is born in mid-summer ; they are helpless at birth, and for several days are carried around by the



THE LONG-EARED BAT

mothers while they search for their own food. When too heavy to carry, they remain in their haunt until about seven weeks old; then they are able to fly and search for food on their own account.

It is doubtful if the bat ever uses its eyes while searching for insect food ; experiments have shown that bats which have been blindfolded and liberated in a room in which several strings were hung from the ceiling were able to avoid them with the greatest ease. To make up for the lack of sight, they seem to be provided with a sense of which we know little, and to which it is difficult to give a name, but which appears to be connected with the 'earlet' of the ten species in the family Vespertilionidæ, and the very remarkable facial development known as the 'horseshoe' on the two species in the family Rhinolophidæ These organs, combined with their keen sense of hearing, assist them to dodge all obstructions, and to find insect food while flying in the dark.

Bats are the only surviving back-boned animals, with the exception of the great class of birds, that are able to fly, but unlike the birds, they are rather helpless except while in the air.

There is a vast field open for the enthusiastic naturalist who cares to undertake the serious, but difficult, study of these nocturnal mammals.

Some excellent work has been done in this respect by Mr. Brian Vesey-Fitzgerald, editor of the *Field*. In the *Proceedings of the Hampshire Field Club*, **16**. Part 1, pp. 64–71, he gives a detailed and valuable description of each of the twelve species found in the county, together with their distribution, founded upon his personal observations.

If naturalists in other counties would follow in his steps, we should gather a deal of valuable information about these much-neglected mammals.

KED-FLIES

THE ked-flies are blood-sucking Diptera, ectoparasitic on certain of the ruminant artiodactyls. Since species occur on domesticated sheep and goats, they are of veterinary significance though not yet incriminated of acting as vectors of actual disease; occasionally they bite man. Information about these flies has been somewhat scattered, and a recent monograph[1] of the group by Prof. J. Bequaert of Harvard is, accordingly, very welcome. Prof. Bequaert has already published many shorter papers on the Hippoboscidæ, of which the Melophaginæ or ked-flies are a sub-family; his monograph of the ked-flies is thus the outcome of prolonged study.

The ked-flies show many interesting adaptations to their ectoparasitic mode of life They are tough, leathery, compact and somewhat flattened creatures All are viviparous, producing larvæ that are fully developed and ready to pupate one at a time. The female reproductive organs are much modified, in a manner very similar to that of the tsetse flies (*Glossina*), for the retention of the larva and its nourishment.

The Melophaginæ comprise four genera, *Neolipoptena*, *Lipoptena*, *Echestypus* and *Melophagus*. Species of the first three genera occur on a variety of goats, antelopes, deer, etc. They are all winged on emergence from the puparium, but the wings are cast when the flies have reached a suitable host. The mature larvæ, on being extruded by the females, apparently fall from the hairy pelts of their hosts and pupate on the ground. The only British representative of this group is *Lipoptena cervi* L., the ked of the red deer[2].

The genus *Melophagus* contains only two species. One of these, *Melophagus ovinus* Linnaeus, the sheep ked, is common in the British Isles[2]. This species is now widespread, having been transported on its principal host, the domestic sheep. It does not, however, survive in all climates. Other hosts from which it has been recorded are the Marco Polo sheep and the Alaskan mountain sheep, but Bequaert[1] states that the ectoparasites of these two sheep have never been properly investigated and that the records are dubious. The other species, *Melophagus rupicaprinus* Rondani occurs on the chamois. The adults of *Melophagus* are completely wingless. In the case of the sheep ked the larvæ do not normally fall to the ground but pupate in the fleece of the host and stick there. Powers of flight are thus not required by the adult when it emerges from the puparium. Nothing is known of the life-history of the chamois ked but, as Bequaert points out, the chamois has an undercoat of short wool beneath the visible pelt of longer hairs.

Bequaert discusses the probable evolution of the Melophaginæ. He considers that the family Hippoboscidæ appeared in the Cretaceous and that they were originally all ectoparasites of birds. He thinks that the passage from birds to the artiodactyls took place when the latter began to arise in the Lower Eocene. There are no fossil Hippoboscidæ but, taking the family as a whole, 65 per cent of the recognized genera and 88 per cent of the recognized species of recent Hippoboscidæ are parasitic on birds. Furthermore, no recent Hippoboscidæ have small mammals as their hosts; and at the time when the Hippoboscidæ appear to have arisen (late Mesozoic) there was a variety of birds but only small mammals. The plumage of any bird offers good protection to larger ectoparasites like the Hippoboscidæ, while smaller mammals can usually kill larger ectoparasites in the pelt.

It would seem that the fate of recent Melophaginæ is intimately linked up with the fate of the artiodactyls, since they have left the birds and have become highly specialized for an ectoparasitic existence on these mammals. This order of mammals has a great past in the Oligocene and the Pliocene, but it is now on the wane. Bequaert suggests that the Melophaginæ may disappear within the next century should the present decline of their wild hosts continue; efficient insecticides may cause the species on the domestic sheep to suffer a like eclipse.

A century hence, naturalists may be consulting Prof. Bequaert's monograph for information about an extinct sub-family of the Diptera.

JOHN SMART.

[1] Bequaert, J, "A Monograph of the Melophaginæ, or Ked-Flies, of Sheep, Goats, Deer and Antelopes (Diptera, Hippoboscidæ)" *Entomologica Americana*, 22, 1 (1942).

[2] Edwards, F. W, Oldroyd, H, and Smart, J, "British Blood Sucking Flies", 118 (1939).

THE INDIAN FAUNA DURING 1942-43

AN interesting tabular statement is given in the *Indian Forester* (70, No. 4, April 1944. Civil and Military Gazette Ltd., Lahore) of the animals shot in some of the Indian Provinces and States during 1942–43. Of British India, only Madras appears to have sent in no figures. The Indian States are confined to Jammu and Kashmir.

The protection of some of the species which two score years ago were in grave danger of becoming extinct has to some extent been safeguarded through the advent of the game sanctuary. Rhinoceros was one of the animals threatened. During 1942–43. only two rhinoceroses were killed in the whole of India. in the province of Assam. Of gaur or bison, 25 only (Madras sent in no returns, unfortunately) were shot. the greater number in the Bombay Presidency (9) and the Central Provinces (8). while none of its close relative the goyal or mithan was killed; nor any banting or tsine. Of wild buffalo, another animal the numbers of which were seriously decreasing, only four were shot in Assam. Wild elephants, killed in British India at least, do not really afford much light on the numbers extant in the different provinces, for the individual public are only allowed to shoot or trap any animal specially proscribed as dangerous or, in the second case, with a special permit from Government. Thirty-two are shown to have been shot in the several provinces; there is a footnote to the statement, however, which says that a few sambar, barking deer and wild elephants—a curious assemblage—were killed by military units in Chittagong District, Bengal.

Turning to the Carnivora, a total of 219 tiger and tigresses were shot, the greater number in the Central Provinces and Berar (65), and the United Provinces (91); of leopard or panther 173 were shot, the United Provinces again heading the list of kills with 54, the Central Provinces 44, and Bombay Presidency 32; the hunting leopard or cheetah is confined, so far as animals shot are concerned, to Coorg (31), and Jammu and Kashmir (15), a curious record in distribution of the animal possibly due to incorrect diagnosis. The records of wild dog (28 shot only) are

disquieting when the ravages among the deer tribe it is capable of committing are remembered; and of the wolf, 1 shot in Sind and 34 in Jammu and Kashmir are zoologically of interest.

The bears, for several reasons connected with their varied and wide distribution, are, from the 1942–43 record, curious. Of the brown bear, only three were shot; Himalayan black bear 64, of which 51 were in Jammu and Kashmir. Malayan bear, for perhaps obvious reasons so far as British records go, nil; sloth bear 28, of which 16 were in Jammu and Kashmir and 8 in the Central Provinces. Of the deer tribe, 255 sambar were shot (C.P 84; U.P. 75; and Bengal 26), and cheetal or spotted deer 291 (U P. 177, C.P. 78, and Bengal 24).

Turning now to the Himalayan fauna, only 4 urial or sharpu were shot, 1 bharal or blue sheep, 7 ibex (Kashmir) and 2 markhor, 5 tahr, no serow, which is curious, and only 10 goral. Of the common little black buck of the plains, the return shows only three shot.

This return for 1942–43 is of some interest and value since it appears to indicate that the large increase in the fighting forces in India has not synchronized with a far heavier mortality in wild animals, as might have been anticipated.

FORTHCOMING EVENTS

Saturday, January 27

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W 1), at 2 30 p m—Mr H. K Bourne: "Electric Discharge Lamps for Photography"

Monday, January 29

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore London, S.W 7), at 5 p.m.—Mr. W. H. Ward. "The Stability of Natural Slopes".

Tuesday, January 30

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Imperial Institute, Exhibition Road, South Kensington, London, S.W 7), at 1.30 p m.—Mrs. Bertild Bekker: "Ma-Maroh" (Devil-Feast).

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C 2), at 2 p m.—Mr. T A. Wedderspoon. "Soil Cultivation" (supporting Intensive Cultivation); Dr. E. W. Russell. "Soil Cultivation" (supporting the Minimum of Cultivation).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m—Prof. T. Wallace: "The Diagnosis of Mineral Deficiencies in Crop Plants", (1) "Visible Symptoms produced by Mineral Deficiencies".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p m.—Sir Alexander Dunbar: "The Future of the Steel Industry".

Wednesday, January 31

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1 45 p.m.—Mr. G Pierce Clingan: "National Building Regulations".

SOCIETY of CHEMICAL INDUSTRY (MICROBIOLOGICAL PANEL OF THE FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2 15 p.m.—Dr. T. F. West and Mr. G A. Campbell 'The Story of D.D.T. and its Role in Anti-Pest Measures".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S W.1), at 6 p m—Discussion on "Welding in Higher Technical Education" (to be opened by Prof. H. Wright Baker and Mr H. Martin).

Thursday, February 1

INSTITUTE of FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 2.30 p.m.—Mr. P. M K. Embling: 'The Gasification of Bituminous Coal in Producers"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 15 p m—Prof. James Gray F R S. "Locomotory Mechanisms in Vertebrate Animals", (1) "Swimming of Dolphins; Gliding and other Types of Movement in Snakes".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INDUSTRIAL RADIOLOGY GROUP OF THE INSTITUTE OF PHYSICS) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Mr. V. E. Pullin: "A Survey of X-Rays in Engineering and Industry".

Friday, February 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p m—Prof E N. da C. Andrade, F R S: "Metal Crystals and Crystal Strength".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP with the MANCHESTER SECTION OF THE S C I) (at the Grand Hotel, Aytoun Street, Manchester), at 6 p m—Dr W J S Naunton "The Influence of Auxiliary Chemicals on the Past and Future Development of Synthetic Rubber"

Saturday, February 3

BIOCHEMICAL SOCIETY (at the British Post-Graduate Medical School, Ducane Road, Shepherds Bush, London, W 12), at 11 a m

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER, Corporation of Barking—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No D 1048 XA) (January 31)

DEPUTY BOROUGH ELECTRICAL ENGINEER Borough of Royal Tunbridge Wells—The Ministry of Labour and National Service, Appointments Dept A3(B), Room 5/17, Sardinia Street, Kingsway London W C 2 (quoting Reference No D 1042.XA) (January 31)

ASSISTANT ENGINEER by the Government of the Tanganyika Territory—The Ministry of Labour and National Service, Appointments Department A3(B), Room 5/17, Sardinia Street Kingsway, London, W C 2 (quoting Reference No E 1149 A) (February 2)

MECHANICAL MAINTENANCE ENGINEER in the Swansea Electricity Department—The Borough Electrical Engineer and Manager, Guildhall, Swansea (February 3)

ASSISTANT IN THE DEPARTMENT OF ECONOMICS for the Farm Management Survey Scheme—The Acting Principal, South-Eastern Agricultural College, Wye, Ashford, Kent (February 3).

LECTURER (full-time) IN MATHEMATICS in the Science Department—The Clerk to the Governors, South-East Essex Technical College and School of Art Longbridge Road, Dagenham (February 3)

LECTURER (full-time) with special responsibility for ELECTRICAL ENGINEERING in the Bolton Municipal Technical College—The Director of Education, Education Offices, Bolton, Lancs (February 5)

METALLURGIST for works in South Midlands on essential war work, and with post-war interests in mass production of refrigerators, domestic equipment, etc—The Ministry of Labour and National Service, Appointments Department A3(B), Room 5/17, Sardinia Street, Kingsway, London, W.C 2 (quoting Reference No. F 3386 XA) (February 6)

GENERAL MANAGER AND ENGINEER OF THE STOCKTON-ON-TEES ELECTRICITY DEPARTMENT—The Town Clerk, Barclays Bank Chambers, Stockton-on-Tees (endorsed 'Electricity General Manager and Engineer') (February 7).

QUALIFIED METALLURGIST for large Iron Foundry by old-established Engineers in East Midlands manufacturing specialized machinery—The Ministry of Labour and National Service, Appointments Dept. A3(B), Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No. F 3127 XA) (February 8)

TECHNICAL LIBRARIAN (female) by small works located in S E London—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No A 770.XA) (February 9)

SPEECH THERAPIST—The Director of Education, Education Offices, 15 John Street, Sunderland (February 12)

LECTURER IN ELECTRICAL ENGINEERING SUBJECTS, and a TEACHER OF GENERAL SCIENCE, in the Ipswich School of Technology—The Chief Education Officer, Education Department, 17 Tower Street, Ipswich (February 16).

UNIVERSITY READERSHIP IN LOGIC AND SCIENTIFIC METHOD, tenable at the London School of Economics and Political Science—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 26).

PSYCHOLOGIST to the Essex Education Committee—The Chief Education Officer, County Offices, Chelmsford (February 28)

UNIVERSITY CHAIR OF CIVIL AND MECHANICAL ENGINEERING, tenable at Queen Mary College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 1)

ASSISTANT SECRETARY jointly to the Glass Delagacy of the University of Sheffield and to the Society of Glass Technology—The Registrar, The University, Sheffield.

GRADUATE TEACHER OF GENERAL SCIENCE in the Burton-upon-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-upon-Trent.

ASSISTANT MASTER to teach MECHANICAL ENGINEERING SUBJECTS—The Principal, Technical College, Wolverton, Bucks.

LABORATORY ASSISTANT (skilled) FOR PHYSIOLOGY DEPARTMENT—The Vice-Dean, St Bartholomew's Hospital Medical College, c/o Queen's College, Cambridge

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Royal Meteorological Society Bibliography of Meteorological Literature Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office Vol 5 No. 6 (July–December 1943); No 7 (January–June 1944). Pp ii+97–152. (London: Royal Meteorological Society, 1944.) 5s. [115

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THE MORAL BASIS OF WORLD ORDER

ALTHOUGH, as was stated by Lord Cranborne in the House of Lords on December 19, the Government is not yet committed to the acceptance of the Dumbarton Oaks proposals for the establishment of a general international organization, those proposals must inevitably form the measure or yardstick against which other proposals will henceforth be judged. Such discussion will be facilitated by the commentary on the proposals which the Government issued in November (Miscellaneous No. 6 [.944]. Cmd. 6571. H.M. Stationery Office, 1944. 2*d*. net). It should be stimulated by the unhappy developments in Greece and in Polish–U.S.S.R. relations, with all the evidence provided thereby of the necessity of a moral basis and of a common standard, not merely of cultural ideals, but also of public conduct, to enable any form of international organization to function.

That was the theme of the debate opened in the House of Lords on December 19, on a motion of Viscount Templewood, urging the strengthening of the unifying forces of Europe by ensuring to every European citizen the fundamental rights and liberties without which European civilization cannot continue. Whether or not we accept the precise proposals of Lord Templewood, which bore some resemblance to the Declaration of the Rights of Man of which Mr. H. G. Wells gave a first draft in his "New World Order", and which some five years ago were discussed with the view of formulating a charter embodying the principles of liberty of thought and freedom from frustration by authority, there can be little doubt that the provision of effective guarantees is, as Lord Cranborne said, a great practical difficulty. It is one thing for nations voluntarily to pledge themselves to maintain and observe certain rights ; it is quite another thing to impose the observance of those rights on them by force.

As Lord Cranborne reminded the House of Lords, and as is stressed in the Commentary on the Dumbarton Oaks proposals, under Chapter 9, the organization is concerned with promoting respect for human rights and fundamental freedoms, responsibility for which is vested in the General Assembly and, under the authority of that body, in an Economic and Social Council. The methods by which such objectives are to be achieved are left to those bodies to determine, and cle .rly the questions referred to by Lord Templewood and others in the debate must be fully explored. At least it may be urged that if the fundamental problem is that of securing the re-acceptance in Europe—and in the world at large—of a common moral standard, that acceptance must be by consent and not by force.

The fundamental method must be education, and while the sombre picture of Europe painted in this debate left no doubt as to the formidable nature of that task, there was a welcome reminder of the spiritual forces on which we can call for aid. The Bishop of Chichester urged that the common culture of Europe is based on four common spiritual traditions : the

humanist, which is largely responsible for the liberal and humanitarian element in our civilization; the scientific tradition, the clearest example of the part played by individual collaboration in European culture; the tradition of law and government; and the Christian tradition. The last, he urged, is the most important, and potentially is capable of unifying the four. Referring to the spiritual quality of the resistance movements and the natural bond existing between patriotic men in the Church and outside the Church inspired by a passion for freedom and justice, he affirmed his belief that the Christian traditions, with those of humanism, science, and law and government, may still prove one of the great unifying forces of Europe, and one of the principal agencies for ensuring his fundamental rights and liberties to every European citizen.

The emphasis thus placed on a moral and spiritual basis does not absolve the great nations—Great Britain, the U.S.S.R., the United States, France—from the responsibility of leadership, as was frankly recognized by Lord Cranborne, and both points are implicit in the latest proposals which Lionel Curtis has outlined for giving effect to the Atlantic Charter. His recent pamphlet* includes the "Open Letter to Lords, Commons and Press" which was included in "Faith and Works". To some extent it covers the same ground as that pamphlet, but its argument is developed out of discussions which arose on the policy outlined in his earlier pamphlets in giving a series of lectures on the same lines to members of the Forces of the United Nations, mainly from those of Great Britain, the Dominions, India and the U.S.A.

The essential part of Mr. Curtis's argument is to be found in the first chapter, outlining a policy for post-war settlement, where the evolution of this policy from his earlier proposals and criticisms is clearly displayed. Agreeing with Walter Lippmann's view in "U.S. Foreign Policy" that no single democracy is now strong enough to prevent world wars, and that only an alliance between the American and the British Commonwealths can keep the peace for the next generation, Mr. Curtis voices his own conviction that the world will not begin to develop any real feeling of security from war until two or more democracies have shown how to merge their external powers in one common authority or union for defence. The danger of world war will be finally ended only when there has come into being an international authority for defence which includes the United States with other democracies. He is convinced that the root cause of world wars is the anarchy which exists between sovereign States, and the only way to stop them is to entrust defence to a common authority.

The federal solution which Mr. Curtis proposes is strictly limited to defence and to functions clearly inseparable therefrom, of which the control of foreign relations, which determine the issues of peace and war, is obviously one. The union authority must be empowered to make the common security from war a first charge on all the resources of all the nations it safeguards. Mr. Curtis himself suggests that the cost should be borne in proportion to the taxable capacity of the several nations forming the union. In arguing for this transition from a national to an international control of defence, he urges that in this way the existing national cabinets and parliaments will have more time to devote to the equally urgent task of promoting social reform

The key point which Mr Curtis reiterates in this, as in his earlier pamphlets, is that the British Government should have the candour and courage to tell the Dominion Governments that Great Britain and Northern Ireland can no longer provide the resources required to maintain forces by sea, land and air strong enough to protect the Commonwealth from further attacks, in accordance with the resolution passed by the Imperial Conference of 1926. From the inability of the British Government to offer effective guarantees to the French, Netherlands and Scandinavian democracies should come an invitation to the Governments of those democracies to join in the discussions with a view to the creation of some common authority equipped to provide a common defence for these countries as well as for the British democracies. Mr. Curtis believes that a union formed in this way would be more likely to secure the adherence of the United States than one which started with the United States and Britain. While paying tribute to the achievements of the League of Nations in technical and social fields such as health and the control of the traffic in drugs and in women and children, he has little faith in the functional approach and rests his case essentially on the stability of organic unions once formed and on the enhanced capacity of democratic governments for overtaking their growing arrears in social reform when they have created a government charged with the task of common defence.

Beyond this, Mr. Curtis lays some emphasis on the union being limited at first to democracies and on centring the capital of the Union from the outset on the North American continent. This scheme is thus narrower in scope and more fundamental than that outlined in the Dumbarton Oaks proposals, but it should be noted that Mr. Curtis is dealing with the long-term rather than the short-term problem; and he insists, with Lord Lothian, that there is no solution to the former problem without the acceptance of some limitations on national sovereignty. An understanding between Great Britain, the United States and the U.S.S.R. may avail to keep the peace during the next generation, but something more fundamental and organic is required beyond that. The Dumbarton Oaks proposals should be examined from the point of view of estimating whether they are likely to afford the necessary stimulus or opportunity for such developments. The Security Council and the Military Staffs Committee proposed at Dumbarton Oaks may be the first tentative steps in the direction indicated by Mr. Curtis, particularly if the regional sub-committees function effectively.

It is significant that much of the above is common ground in other proposals besides those of Mr. Curtis which have recently been advanced. Sir Walter

* The Way to Peace. By Lionel Curtis. Pp. 98. (London: Oxford University Press, 1944.) 1s. net.

Layton, for example, in his Sydney Ball Lecture, "The British Commonwealth and World Order"*, from a survey of the distribution of population, territory, and industrial and commercial resources, concludes that we should advance to world order by the regional development of closer relations between nations. At this stage we should not put into a universal world covenant anything more than simple provisions for security and for consultation. The regional arrangements should include the internal security of the groups themselves, that is, political provisions which will foster and guarantee personal liberty and economic collaboration to raise the standard of living. Meanwhile, however, a world association of a looser kind is necessary both to keep world peace and to ensure that all regional arrangements are consistent with the interests and progress of the world as a whole and will not break it up into sections, the conflicting aims of which may contain the seeds of future conflict.

The looser association Sir Walter Layton suggests would be organized under the direction of a council containing representatives of the Great Powers, the large world groups, Latin America and the Moslem world. Above all, he insists—and here his proposals run more in line with those of Mr. Curtis—on the urgent necessity of a radical advance towards unity in Europe in order to secure lasting peace. Here again he sees the solution in some form of federalism, which will, in Mr. Churchill's words, secure "the largest common measure of the integrated life of Europe that is possible without destroying the individual characteristics and traditions of its many ancient and historic races". The federal scheme which should cover all Europe outside the U.S.S.R. and Great Britain, and would be actively sponsored by those powers as well as by the United States, should place all the armed forces of Europe under the European authority or council, and a European Supreme Court should be established. The scope of the authority in economic matters should include supervision of the munitions industries and the regulation of cartels, and control, so far as possible, of all matters of inter-State commerce, especially rail and air transport; and Sir Walter refers in this connexion to the importance of continuing the existing organs of the United Nations for the distribution of food and raw materials. Finally, he insists that the lines of European union should be settled by the European peoples themselves before any final peace is made with Germany.

Sir Walter, discussing last the role in world affairs of the British Commonwealth, points out that within the framework of such a world organization there would be advantage and no harm in close and continuous consultation between Britain and the Dominions. Moreover, we should not imagine that democracy in any stereotyped form will spread to countries where it has not hitherto existed; but the ideals expressed in the Four Freedoms are goals to which people of every race and colour do aspire, and we can give the leadership for which the world is looking by demonstrating in our own domain that these aims can be attained, and using our great influence in international affairs to assist other nations to achieve them. Ultimately, it is these ideas that will unify the world.

Mr. Ely Culbertson closes his "Total Peace"* on a like note, but what professes to be the full exposition of his world federation plan already published in summary is a disappointing volume. The analysis of the present basis for peace, namely power politics, which occupies the first part of the book, scarcely provides a true historical perspective as claimed. Moreover, it sometimes seems more calculated to foster international misunderstanding and distrust than the policy of co-operation represented by the plan Mr. Culbertson seems to forget that some measure of good faith and common standards of value and conduct must be presupposed in any attempt to formulate an agreement whatever the sphere of action. The second part of the book gives a somewhat fuller exposition of the world federation plan than that in the "Summary" published last year.

There is, it is true, a superficial resemblance between some of Mr. Culbertson's thought and that of Mr. Walter Lippmann. Mr. Culbertson frankly accepts American power politics as essential, but argues that they must be based on the renunciation of wars for the purposes of economic or political conquest. The ultimate object of American power politics must be the elimination of power politics in relations among States. Meanwhile, he lays down three basic principles for American power politics: first, the United States cannot permit any other great State to increase its power materially through conquest or domination; further, the United States must use its present power to ensure itself strategically against possible future aggression by one or more sovereign States; and, finally, it must establish, if possible, an adequate system of world collective security.

Mr. Culbertson bases his belief in the possibility of collective defence on the segregation of the heavy weapons of war and the quota force principle, as already explained in his "Summary". From his third basic principle he derives the corollary that a system of collective defence acceptable to the United States must provide for all possible contingencies and must not deprive the United States either of its sovereign rights (except the right to wage war of aggression) or of its own military power to defend itself, as well as the further corollary that until a system of collective defence is fully established and thoroughly tested in operation, the United States must not abandon the first and second principles. All three principles or instruments must be used in United States foreign policy, and Mr. Culbertson gives vividness to his discussion by three charts in which is set forth the world pattern of 1945 and 1975 in comparison with that of 1900.

From this basis Mr. Culbertson proceeds to destructive criticism of the policy advocated by Mr. Walter Lippmann in "U.S. Foreign Policy" and E. H. Carr in "Conditions of Peace"; and while he argues that the United States must not withdraw from Europe

* Barnett House Paper No. 27. (London: Oxford University Press, 1944.) 6*d*.

* Total Peace: What makes Wars and How to Organize Peace. By Ely Culbertson. Pp. 274. (London: Faber and Faber, Ltd., 1944.) 12*s*. 6*d* net.

into isolation, he urges that she must oppose the establishment of any kind of British or Russian zone of influence in Europe. On the contrary, the United States must endeavour to restore their sovereign status as soon as possible to the liberated countries, and remain in Germany until the German people also are restored to a position of independence from the power politics of either Britain or the U.S.S.R.

These chapters of the book are profoundly disheartening and depressing. Mr. Culbertson, it is true, like Mr. Curtis, points to the essential weakness of the British Commonwealth in regard to defence, but though at times his criticism is suggestive, it is often shallow and unfair. True, he wishes to see the British Commonwealth preserved, and rightly says that the only lasting guarantee of its preservation lies in a system of collective security for the world. Unfortunately, he seems to forget 'sauce for the gander, sauce for the goose'; and his argument for a system of collective security often appears to be inspired by a desire to perpetuate United States domination rather than by a conviction that her own true interests, like those of other nations, are best served by a collective system of security.

The two faults that seem to run through Mr. Culbertson's thinking are first his failure to recognize that the United States, no less than other nations, cannot have matters all her own way: in any system of co-operation, international or not, there must be give and take. Inflated nationalism in the United States or in the liberated countries of Europe will assuredly be a stern obstacle to a collective or federal system. Secondly, Mr. Culbertson is too prone to impute bad faith to other countries. Confidence in the willingness of the United States to participate in a collective system will not be fostered by insisting on the necessity of strong safeguards against bad faith on the part of any and all other nations. It is, in fact, uneasiness about the extent to which the United States can be depended upon that, more than any other factor, is liable at the moment to paralyse the developments of the United Nations Relief and Rehabilitation Administration and the Dumbarton Oaks proposals. The outspoken article "Noble Negatives" in a recent issue of the *Economist* was a true service to the United Nations, no less than to the United States itself.

Mr. Culbertson's realism is in fact overdrawn. His anxiety to criticize destructively other schemes, such as the League of Nations and the Federal Union proposals of Clarence Streit, leads him to overlook the fact that all organizations or systems depend on human will-power and sympathy for their operation. Had there been sufficient determination, the League of Nations, with all its imperfections, might still have achieved its purpose. However mistaken President Wilson's tactics or maladroit his handling of the situation, and however understandable in the circumstances of 1919 the refusal of the United States to participate, that refusal wrecked the whole scheme, and there is nothing in Mr. Culbertson's book that encourages any confidence that that refusal will not be repeated on even less substantial grounds in the future. Nor will confidence be restored by imputing bad faith to attempts to evolve an alternative system which might function without the co-operation or participation of the United States.

Unless this question of good faith and understanding is frankly faced, there can be no hope of any real progress with the Dumbarton Oaks scheme or with any other. Criticism of mistakes there must rightly be, but that criticism should be tempered by the recollection that mistakes may be made in good faith and through information less complete than that available to the critic. Above all, criticism must be responsible. If a world order is to be established after the War and a scheme of collective security operated, refusal to participate in a particular scheme must be accompanied by constructive proposals for an alternative scheme and a willingness to consent to mutual accommodation. The spirit in which the problem is approached is what matters, and without some moral basis there can be no hope for an enduring system of world order.

If the upheaval of war affords opportunities by shattering old institutions and loosening old associations, it also creates obstacles by the passions it arises. In a long war tempers are tried, and men and women worn to the limit of human endurance may fail to view their problems with the patience, forbearance, understanding and wisdom all-important in such vital issues as those of world co-operation and reconstruction. That may well be a decisive reason for advancing slowly, taking the organizations set up for our war purposes, whether regional or functional, and adapting them to the new purposes of peace and reconstruction; and as confidence and sympathy are gained in working together, shaping them and completing them where required to form a wider and comprehensive system which gives full satisfaction to the needs and aspirations which the Dumbarton Oaks proposals are intended to meet.

THE PHILOSOPHY OF BERTRAND RUSSELL

The Philosophy of Bertrand Russell
Edited by Paul Arthur Schilpp. (Library of Living Philosophers, Vol. 5.) Pp. xvi+815. (Evanston and Chicago: Northwestern University; London: Cambridge University Press, 1944.) 30*s*. net.

A HIGH standard is reached by most of the twenty-one essays in this imposing volume. Limitations of space make it impracticable to notice them separately; but some account may be given of the picture of Russell and his philosophy which emerges from the work as a whole.

Bertrand Russell was born in 1872, the grandson (and ultimate heir) of the Whig statesman Lord John Russell, who was twice Prime Minister in the earlier half of Queen Victoria's reign. His mother was one of the Stanleys of Alderley, a family which has contributed many distinguished (and, it may be added, many picturesque and uncommon) figures to English public life. Both parents having died when he was a child, he was brought up by governesses and tutors,

and in his solitary studies pondered over questions which are not easily answered At the age of eleven he was troubled over the foundations of geometry; by the time he was fifteen, he had become convinced that free-will was an illusion; and the next three years saw the destruction of his beliefs in immortality and in God.

During this period, Russell was influenced chiefly by the writings of John Stuart Mill. Now Mill, while generally following in the philosophical tradition of Hume, had tried to rescue mathematics and physics from the universal bankruptcy of knowledge which had been brought about by Hume's critical scepticism; and it was this aspect of his teaching that fired the imagination, and eventually determined the life-work, of his young disciple. Mill's own solution was, in brief, that the character of necessity ascribed to the truths of mathematics, and even the peculiar certainty sometimes attributed to them, was an illusion, and that the axioms of geometry were inductions from experience Russell found himself reluctant to accept the conclusion that mathematical propositions are empirical generalizations, though at the time he could not imagine what else they could be.

Russell's life of isolation ended at the age of eighteen, when he went up to Cambridge, which opened to him a new world of delight. He read for the Mathematical Tripos, and was seventh wrangler in 1893; after this he transferred to philosophy, then represented at Cambridge by Henry Sidgwick, James Ward, G. F. Stout and J. E. McTaggart; but the dominant influence on his thought came not from any of these but from A. N. Whitehead, who as a member of the mathematical staff was lecturing on non-Euclidean geometry; and Russell spent his fifth year in composing a dissertation on the foundations of geometry, which won for him a Trinity fellowship in 1895.

Russell's philosophical teachers had by this time drawn him away from the school of Mill. The metaphysical system presented by Stout and McTaggart was the absolute idealism of Hegel, which he accepted for a time; he became interested also in the neo-Hegelian idealism of F. H. Bradley, whose "Appearance and Reality" was published in 1893; but it soon became clear that no satisfactory solution of the problem which dominated his thoughts—the discovery of a satisfactory philosophy of mathematics—was to be found in these quarters; and in 1898, chiefly under the influence of G. E. Moore—then a newly elected brother fellow of Trinity—he renounced German idealism completely, and, moving swiftly to the opposite pole of doctrine, came to believe that the material world of common sense exists, independently of whether anyone is aware of it, and also that there is a timeless world of Platonic ideas; that a search for reality is possible, characterized by all the seriousness and assurance of scholasticism, and at the same time in harmony with modern science; and that mathematics could be *quite* true.

The new outlook, however, did not immediately suggest any means by which this last confidence could be formally vindicated. Russell's great inspiration, the crisis of his intellectual life, came in 1900, at the International Congress of Philosophy in Paris, where he heard expositions of recent progress in symbolic logic; that is, the development of the principle that certain ideas in logic are the constitutive elements of all others, just as in chemistry all molecules are constituted of certain chemical elements, these ideas can be represented by symbols, and the ideograms thus introduced are capable of replacing ordinary language completely for the purposes of any deductive theory. Russell was not unfamiliar with the subject, for it had been originated by Leibniz, of whose work he had made a close study; but he now learnt of the advances which had been made in the 1890's by Giuseppe Peano (1858–1932), of the University of Turin, whose ideography was far more powerful than anything previously devised.

Russell saw at once that with the help of Peano's logical calculus, it should be possible to extend the domain of precise reasoning backwards into regions which had hitherto been dim in the twilight of philosophy, perhaps even to discover the true foundations of mathematics Peano himself had not achieved this; indeed he belonged to the 'formalist' school, who hold that any branch of mathematics consists of *primitive or undefined concepts* (for example, the concept of the straight line in geometry), *definitions* (that is, short names for complexes of ideas), *axioms* (that is, fundamental propositions which are assumed and which may be regarded as constituting an implicit definition of the primitive concepts), *existence-theorems* (proofs of the consistence and independence of the axioms, the existence of the entities introduced by the definitions, etc.), and *deductions*. In accordance with these principles, he based arithmetic on the 'undefined concepts' *number*, *successor* and *zero*; which was unsatisfactory, for it is precisely these three concepts whose nature is in question. It ought to be possible to define what number is, for the statement that we have ten fingers, two ears and one nose is intelligible to everyone; yet the definitions in the text-books of philosophy, such as "every number is a plurality held together as a unity", were obviously worthless.

Throughout the academic year 1900–1 Russell, who by now had an easy mastery of the Peano symbolism, worked at the problem and succeeded in proving that the whole numbers 1, 2, 3 . . can be defined in terms of purely logical concepts (such as *class*, *not*, *or*) by means of the ideography, and that all pure mathematics can be built up on this foundation: thus 'mathematics is identical with formal logic'. This statement is obviously incompatible with the empiricist philosophy of mathematics which Russell had learnt from Mill, and also with the Kantian doctrine which he had learnt from his Cambridge teachers. According to Kant, mathematical proofs depend not on formal logic alone, but also on certain *a priori* 'forms of intuition', namely, space and time, so that, for example, the diagram is an essential part of geometrical reasoning. Russell's work demolished the empiricist and the Kantian views alike. Subsidiary to this great discovery, many improvements were introduced into the symbolic calculus itself; particularly a general theory of relations (the lack of which had been a defect in the older logic), the concept and extensive use of the propositional function (that is, an expression such as 'x is a number' which contains a variable x and which becomes a proposition as soon as a definite value is assigned to the variable) and the treatment of implication ('p implies q' was defined as equivalent to 'either p is false or q is true', so that a false proposition implies every other proposition).

Russell's researches, in which he had throughout the intimate co-operation of Whitehead, were followed

eagerly by the younger mathematical fellows of Trinity College (E. W. Barnes, G. H. Hardy and myself), and in the Michaelmas term of 1901 he gave a course of lectures to an audience of half-a-dozen junior dons, dictating to us what might be described as the first draft of "Principia Mathematica". It would perhaps not be extravagant to regard these lectures as effectively the beginning of the modern renaissance in logic While due credit must be given to Russell's precursors, especially to C. S. Peirce, Frege and Peano, it may be said broadly that the great expansion is to be dated from the "Principia". The successive volumes of the *Journal of Symbolic Logic* show that the best work is now being done in America.

The career of discovery had its dramatic moments. I remember Russell's look of mischievous glee when he announced a contradiction inherent in logic, which invalidated all human reasoning, this was, that if x is the class whose members are all the classes which do not contain themselves as one of their members, then from the assumption that x is a member of itself we can at once infer that x is *not* a member of itself, and *vice versa*. There are an infinite number of contradictions of this kind, and in order to deal with them, Russell introduced what is essentially a rule of syntax, imposing a ban on the construction of certain kinds of linguistic expressions, and thereby avoiding all formations which could lead to logical contradictions. The scheme depends on a classification of the objects of thought into a hierarchy of 'types', the rule being that the symbols which it is permissible to insert into any one context must be such as represent entities of the same type. The simple theory of types as originally formulated by Russell suffices to remove all those contradictions which are expressible in purely mathematical or logical terms: there are other contradictions, of a type called 'semantical' by his disciple Frank Ramsey, and these, as has been more recently shown, can be avoided by extending the theory of types into an analogous theory of 'levels of language'.

Russell has had to defend his position not only against formalists, Kantians and empiricists, but also against the school of mathematical philosophers known as 'intuitionists', who fix attention on the fundamental ideas of truth and falsehood, and ask Pilate's question, "What is truth?". Truth, they say, means 'verifiability'; it would be a meaningless word unless there were ways of ascertaining whether particular propositions are true or not. Now in mathematics, when we are dealing with infinite systems, we meet with difficulties in this regard. Suppose, for example, we consider the proposition "In the number $\pi = 3{\cdot}1415926536\ldots$, the sequence of digits 123456789 occurs at least once". Here no method exists which in principle would enable us to prove by a finite number of operations that this proposition is false. In such a case, the intuitionists deny that there is justification for asserting *a priori* that it is necessarily either true or false; a third category must be admitted, of indeterminate propositions; that is, the Law of the Excluded Middle, that 'every proposition is either true or false', is not of unlimited validity; in place of the two-valued traditional logic we obtain a three-valued logic. Russell's answer is, in brief, that while a three-valued logic may be admissible, there is no reason to suppose that the two-valued logic is inadmissible; and that the latter is to be preferred because of its greater potency for the development of mathematics and physics. The abandonment of the Law of the Excluded Middle would, in fact, make it necessary to regard large domains of traditional science as invalid.

Russell's discoveries in mathematical logic brought about some modifications of his philosophical outlook. In 1898 he had regarded the cardinal numbers as belonging to the timeless world of Platonic ideas. In 1900–1, when he had defined 'number' in terms of the logical concept of 'class', it became no longer necessary to retain numbers as entities, and their ideal character was transferred to classes. But further reductions in the population of the Platonic heaven were to follow. In a celebrated paper "On Denoting", written in 1905, he discussed 'denoting phrases', and in particular 'descriptions', that is, phrases of the form 'the so-and-so'; for example, "the author of 'Pendennis'". Some descriptions, such as "The Bishop of Oxford", apply to objects which exist, while others, such as "The Bishop of Asquith", do not. Reflexion on this difference had led to some muddled thinking by philosophers, the opinion being expressed that since "The Bishop of Asquith" could sustain a predicate (thus, "The Bishop of Asquith has no valid Orders"), he must have 'being', though not 'existence'. In this paper, which was published in *Mind*, Russell's powerful logical analysis shattered such nonsense for ever. He showed how to reduce any proposition in which a denoting phrase occurs to a form in which no such phrase occurs, by recasting it into a statement about the values of a variable that satisfy some propositional function. The true analysis of the proposition is different from what was suggested by the grammar of its original formulation.

The logical analysis of description, then, does not lead to a definition of the descriptions themselves, but transforms the propositions in which they occur, in such a way that the descriptions are eliminated. The descriptions are not assumed to be themselves significant, though they are parts of significant sentences, just as the symbol of differentiation in the differential calculus acquires significance only when performed on an operand. The technique of the theory of descriptions was later (in 1910, in "Principia Mathematica") applied to all kinds of symbols which have a meaning in use (that is, in a context with other symbols) but not in isolation—'incomplete symbols', as Russell called them. He now showed that class-symbols could be regarded as incomplete symbols; thus statements about classes can be replaced by statements which mention only properties of the individuals who are (in the usual way of speaking) members of the classes; so that a class is not a genuine entity, but a 'logical construction', as Russell calls it.

The theory of incomplete symbols was afterwards used extensively in order to reduce the traditional entities of mathematics and (after the completion of "Principia Mathematica") also of physics—points, instants, particles of matter, etc.—to logical constructions from empirical data. Scientific statements were thus related directly to sense-experience, and the traditional entities became superfluous. For a dozen years or more from 1914, Russell was much occupied in building up by this method a philosophical system of physics, taking as his fundamental principle William of Occam's maxim *Entia non multiplicanda sunt praeter necessitatem*, or as he formulated it in this connexion (Russell's 'Principle of Parsimony', as we may call it). "Wherever possible, substitute constructions out of known entities for inferences to unknown entities", so as to reduce the number of

inferred entities to a minimum. The raw material of the constructions consists of 'events', an event being something which occupies a small finite amount of space-time: thus electrons and protons are now constructed as series of groups of events. Russell's success in the endeavour to obtain by his constructions a 'minimum vocabulary' led to a change in his views regarding the problem of universals: in 1900 he had accepted the Platonic doctrine, but to-day one might perhaps describe him as a Parsimonious Realist, who believes that at least one universal is necessary, but is reluctant to admit any more.

It is to be remembered that Russell had come to philosophy through mathematics, and that a 'principle of parsimony' is naturally congenial to mathematicians, who enjoy showing that all the laws of the material universe are nothing but particular applications of Hamilton's Principle. In Russell's case, philosophical parsimoniousness gradually got a greater and greater hold, and eventually drove him into a new metaphysical position—caused him, in fact, to abandon the dualism of mind and matter which he had maintained for so long, and to revert to a monistic interpretation of the universe: not, however, to what he had renounced in 1898, but to a newer philosophy which had originated with William James and the American neo-realists, and which was known as 'neutral monism'.

The change came gradually. It began, in the first edition of "Our Knowledge of the External World" (1914), with a move towards a phenomenalistic doctrine of matter: a physical 'thing' was there defined as a certain series of 'aspects'; namely, those which would commonly be said to be *of* the thing. For purposes of explanation, an 'aspect' may be thought of simply as what would be shown in a photograph of the universe taken from a certain point of view; a set of aspects constitutes one 'thing' when they form a group related to each other according to the laws of perspective; the aggregate of these aspects, perceived and unperceived, *is* the thing. This definition is obviously very much in the spirit of the definition of a cardinal number as a class of classes. The second stage was reached in "The Analysis of Mind" (1921), where Russell rejected the belief in consciousness as a fundamental characteristic of mind, which he now reduced to sensations and images.

Having arrived at the position that both matter and mind are bundles of ultimate constituents, the final step is to declare that these constituents, the aspects, are not specially either material or mental, but are the same 'neutral stuff' in both cases. Mind and matter are logical constructions: the difference between them consists in the different relations according to which the neutral entities are arranged, just as an ordinary dictionary consists of words arranged according to the alphabetic order of their initial letters, whereas a dictionary of rhymes for the use of versifiers may consist of the same words arranged according to the sound of their final syllables. Since the neutral entities are directly perceivable (or at least would be perceived if there were observers everywhere), the philosophy is essentially empirical, and indeed in some ways it recalls the teaching of Russell's first instructor, John Stuart Mill. The doctrine was somewhat modified in "The Analysis of Matter", published in 1927.

The advocates of neutral monism diverge considerably from each other in their presentations of it: and a close examination has revealed many difficulties; the criticisms of Russell's version by Prof. A. O Lovejoy in his book "Revolt Against Dualism" and by Prof W. T. Stace in the present volume are impressive. On the whole, one feels that a metaphysic of this type is not likely to find wide acceptance except among those philosophers who have a strong *a priori* preference for monism over dualism. As Russell admits, such a preference cannot be based on any rational objection to dualism: it is, perhaps, most often the fruit of a more or less mystical belief in parsimony as a fundamental principle of the universe.

Russell's best work—and very wonderful work it is—has all been related in one way or another to logic: the reduction of mathematics to logic, the analysis of linguistic form (logical atomism), and the application of logical constructions in the philosophy of science. Mr. Santayana once remarked that he was inclined to say of Russell what Russell had said of Leibniz, that his philosophy was at its best in those subjects which are most remote from human life With this judgment I agree: and so (space being limited) will confine myself to the bare mention that parts of the work under review deal with politics, sociology and religion.

EDMUND T. WHITTAKER.

GALEN AND THE EMPIRICAL SCHOOL

Galen on Medical Experience

First edition of the Arabic version with English translation and Notes by R. Walzer. (Published for the Trustees of the late Sir Henry Wellcome.) Pp xi+164. (London, New York and Toronto: Oxford University Press, 1944.) 12*s*. 6*d*. net.

FABRICIUS, in his "Bibliotheca Graeca" (1717), lists one hundred and seventy treatises by Galen still extant; his list of treatises lost fills six and a half quarto pages. Kuehn's edition of Galen's works (1821–33), in spite of all its faults and for many years to come the best accessible collection, comprises twenty-two volumes. Ever since 1906, lost treatises by Galen have been recovered and edited—in Arabic versions. "On Medical Experience" is one of these 'lost' treatises. Its only manuscript was discovered in 1931 by H. Ritter at Istanbul. Here is the first edition of the Arabic text, which dates from the middle of the ninth century, with an introduction, English translation, and explanatory notes (chiefly sources and cross-references)—the work of R. Walzer, whose experience and previous work in the fields of Arabic and Greek science and philosophy account for the admirable execution of his task. The work is exceedingly well produced at a surprisingly low price.

There was first a translation from the Greek original into Syriac from the pen of the celebrated Syriac Hunain ibn Ishāc, the present Arabic text being a re-translation from the Syriac into Arabic by Hunain's well-known nephew, Ḥubaish. Hitherto only certain Galen fragments had been known to be of importance in the history of Greek epistemology, and by an ingenious guess had been attributed to the lost treatise "On Medical Experience". This guess has now been confirmed by the discovery and editing of the full treatise. It is certainly a genuine work by Galen, a product of his early days, and its chief importance lies in the

material which it adds to our scanty knowledge of the so-called Empirical School

Greek medicine reached its first climax in propounding a number of free observations, speculations and practical rules such as have come to us in the corpus of Hippocratic treatises In the course of one or two centuries, free Hippocratic speculation and observation had developed into a rigid and dogmatic system. This, in due course, aroused strong antagonism—the Empirical School, the main tenets of which are reviewed in the present treatise. In this Galen wishes to give, for educational purposes, an example of a speech typical of a representative of the original Empirical School. He refrains from giving his own views, but lets the empiricist win against his dogmatic opponent. Whatever Galen's personal attitude towards empiricism, he may be seen as the embodiment of the second climax of Greek medicine, owing to his final combination of dogmatism and empiricism, which enabled him to raise medicine to the rank of an applied science based on experimental physiology and therapy. This places the importance of the present treatise in the right perspective. It sets out a discussion which may not be without significance in the philosophy of science and medicine in general, quite apart from its historical background and implications.

The dogmatist opens the discussion by declaring the 'Logos', that is, the knowledge of the 'invisible' laws behind the obvious and 'observable', to be essential. It limits the innumerable possibilities offering themselves to the person who confines himself to observation. As the alphabet enables us to comprehend the innumerable possible sounds, systematic knowledge cannot be dispensed with, if observation is to serve a purpose. It is the appreciation of the order of symptoms rather than mere observation of symptoms that matters. For example, convulsion following fever is a certain sign of death; fever following convulsion a sign of safety. The empiricist retorts with the arguments famous from other sources, for example, Celsus, that a sailor is able to sail at a given moment without having fathomed the 'Logos' of Nature, of elements and winds, etc. It is lack of experience, not of knowledge, by which the medical man is bound to fail, and it is the yearning for systematized knowledge which accounts for the divergencies in opinion as to the nature of such simple phenomena as digestion, which has been attributed in turn to cooking, decay, trituration and to heat, although mere observation shows that none of these processes can explain it. The dogmatist should say how the discovery of remedies, certainly a pure product of empirical search in Nature, can become what he calls 'technical knowledge' in which alone he places confidence. Obvious entities such as a 'pile of wheat', a 'people', an 'army' could be explained away if we start asking how many constituents are necessary for them—the logical trick of the 'Sorites' which is being refuted at length.

Most points which the empiricist makes in this discussion belong to the household stock of arguments of scepticism, medical and philosophical, such as formed a strong current of thought when, in the sixteenth and seventeenth centuries, the foundations of modern science and medicine were laid. Then Vesalius, Harvey, Van Helmont based their revolutionary views on a refutation of Galen and his system. It should be remembered, however, that criticism of systems such as advanced by the ancient empiricists was largely destructive, and directed in particular against anatomy and physiology as the 'scientific' basis of medicine. It was constructive only in the discovery of new 'pharmaka'. On the other hand, the reader may be referred to the Linacre Lecture of 1943, in which Prof Major Greenwood vindicated Galen, the experimentalist, keen observer and medical thinker, against the ill-fame of a dictator whose dogmatism is often said to have prevented progress in medicine for fifteen hundred years.

W PAGEL

"STATISTICAL METHODS"

Statistical Methods for Research Workers

By Prof. R. A Fisher. (Biological Monographs and Manuals, No. 5) Ninth edition, revised and enlarged Pp. xv+350. (Edinburgh and London : Oliver and Boyd, Ltd., 1944) 16*s*. net.

THE appearance of a further edition of "Statistical Methods for Research Workers" might easily pass almost unnoticed, for nine editions have appeared at regular intervals in the last nineteen years. In fact, the cessation of this flow would be more remarkable than its continuation. Yet we may be forgiven if we take the opportunity to glance back over the career of this now standard work, since familiarity may easily lead us to overlook its effect on biological and other research.

In 1925 the first edition was received with a coolness verging at times on hostility. While the originality of the work and the importance of the small sample theory which formed its basis were acknowledged, it was doubted whether Prof. Fisher's readers would be prepared to accept his methods in the absence of formal proofs. It was hinted that the soundness of these methods might not justify the author's confidence. It was feared that biologists in particular might well find the book unnecessarily difficult to read. In practice, of course, the soundness of Fisher's methods has been attested, partly by mathematical investigation, but perhaps more importantly in the biologist's eyes by the fact that they work. In fact, they work so well as now to be indispensable. In these circumstances, biologists, at least, have seldom felt called on to demand formal mathematical proofs prior to use, and while biologists have at times complained of finding the book difficult (which complaint may equally be taken as reflecting the deficiencies of current training in biological research), few have let this difficulty blind them to the profit which they gain from using Fisher's methods. The consequences are to be seen not merely in the improved analysis of biological data, but also in the improved design of biological experiments—an aspect of the subject which Fisher has always stressed. In its turn the book has benefited by being steadily expanded to include the new techniques which have arisen from the problems it has encouraged biologists to pose to its author. Two special outgrowths, which we may note, are "The Design of Experiments" and "Statistical Tables", the origins of which may be seen in the earlier work.

"Statistical Methods" is in fact, as already said, now a standard work, which has exercised, and must continue to exercise, its influence on research methods especially in biology. It is justly recognized as an essential part of all biological libraries and research laboratories.

K. MATHER.

A QUANTUM THEORY OF THE ORIGIN OF THE SOLAR SYSTEM

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THE hypothesis of Kant and Laplace that the solar system originated by a gradual process from the contraction of a rotating nebula has become more and more improbable as the theory of such a process was investigated (cf. Jeans[1]). As a consequence, catastrophic theories of its origin have been put forward. In these theories another star, or even two stars, passed close to the sun, or collided with it. In this article, which lays no claim to do more than open the discussion of possibilities, I suggest a quite different catastrophic origin, namely, a quantum transaction or perhaps a series of such transactions. I shall try to show that on Milne's[2] cosmological theory, this is a plausible hypothesis, and further that certain other cosmological problems are made less difficult if it is accepted.

According to Milne's cosmology, the universe can be represented in two distinct ways. On the kinematical representation, time t has a finite past t_0 of about 2×10^9 years or $6 \cdot 3 \times 10^{16}$ sec. Space is Euclidean, but every observer on a 'fundamental particle' has his own private space. The infinite assemblage of fundamental particles, identified with the nuclei of galaxies, is contained in a finite sphere of radius ct, expanding with the velocity of light. An observer on any particle judges himself to be at the centre of this sphere, with the others receding from him. The different private spaces are related by the Lorentz–Larmor transformation. On the dynamical representation the time $\tau = t_0 (\log t - \log t_0 + 1)$ has an infinite past, and the fundamental particles are at rest in a public hyperbolic space. The radii of planetary and atomic orbits are constant, as are the periods of planets and electrons, whereas in kinematic time and space the orbital radii and angular momentum increase with t.

One difficulty of the collision or encounter theory is the extreme rarity of such events. On some versions of the expanding universe theory such encounters were more probable in the remote past, when the stars were densely packed. But in Milne's cosmology an encounter was never more probable in a given stretch of dynamical time than it is now. It could be argued that as the dynamical past is infinite, an encounter is certain. However, it is no part of Milne's hypothesis that the stars have always existed.

Milne has not yet succeeded in deducing quantum mechanics from his few and simple postulates. His mechanics are in fact mainly classical. However, he has considered the behaviour of photons. The quantum parameter h, defined as E/ν, where E is the energy radiated in a transition, and ν its frequency, is invariant on the kinematical time-scale, for the red-shift of the distant galaxies is explained by the Doppler effect due to their recession; and the energy radiated in an atomic transition is invariant on either scale.

The main difficulty to be overcome in any theory of the origin of the solar system is this. The total angular momentum of the system is about $3 \cdot 3 \times 10^{50}$ erg-seconds. This is conserved on the dynamical scale. Unless most of the mass of the sun is concentrated in a very dense core, all this angular momentum could be present in the sun, due to its rotation, without its showing any more tendency to burst than does Jupiter at the present time. Hence some external source of energy must be postulated before it could emit the matter which condensed into the planets. The source of this energy has usually been supposed to be a star. I suggest that it may have been a photon.

The mass of the sun is about $2 \cdot 0 \times 10^{33}$ gm., that of the planets about $0 \cdot 00134$ of this value; the solar radius 7×10^{10} cm., and the gravitational constant $6 \cdot 66 \times 10^{-8}$. The mechanical energy of the solar system is almost wholly given by the work required to lift the planets to their present orbits against solar gravitation. This again is almost equal to the work required to lift them to infinity, namely, $\gamma m M/R$, where γ is the gravitational constant, m and M the masses of the planets and sun, and R the solar radius. The kinetic energy and the energy of the fall from infinity to the present orbits involve corrections of the order of $\gamma m M/r$, where r is the radius of a planetary orbit. Since for Jupiter $r = 1100R$, these can be neglected.

$$\frac{\gamma m M}{R} = 5 \times 10^{45} \text{ ergs.}$$

Now at first sight a photon of this energy (and therefore of mass 6×10^{19} tons) appears a ridiculous conception. It would have, on the kinematical scale, a frequency of 8×10^{71} sec.$^{-1}$, and a wave-length of 4×10^{-62} cm. But now consider the conditions at time t, when t was very small. The radius of the universe was ct. It could not accommodate radiation of a wave-length greater than ct, and the past would be too short for such radiation to have accomplished even a single oscillation. At any time t there is a minimal possible size of photon, the frequency of which is of the order of t^{-1}. Probably it is a good deal less. This is borne out by the following consideration.

The mean lives of excited atoms liable to radiate light of visible frequency always appear to exceed 10^{-8} sec., though shorter lives are associated with higher frequencies. Thus out of a group of excited atoms existing from the beginning of kinematic time, only a minority would have radiated before $t = 10^{-8}$ sec., when the universe had a radius of 3 metres, or about 10^7 wave-lengths. At a time of the order of $t = 10^{-15}$ sec. there could, on any hypothesis, have been extremely little visible radiation, as it could not have been produced by the ordinary radiation processes. This argument suggests that radiation of frequency less than t^{-1} is impossible, while radiation with a frequency less than about $10^6 t^{-1}$ is produced, if at all, with some difficulty.

We can conclude, then, that at $t = 10^{-72}$ sec. the minimum photon corresponding to a completed oscillation would have had an energy of about $6 \cdot 5 \times 10^{45}$ ergs. So if there was any radiation at all at this time, it was sufficiently hard to lift the planets out of the sun, if the sun absorbed it. Its contribution of momentum would of course have been negligible. If some planetary matter was shot out of the solar system, and if some hydrogen was lost even from the major planets, the energy required must be multiplied by a small factor. If the radius of the sun was larger it must be divided by a small factor. But we can conclude that the earliest date for the formation of the solar system is about $t = 10^{-72}$, or $\tau = -4 \cdot 1 \times 10^{11}$ years, that is to say, the earth cannot have revolved round the sun much more than 4×10^{11} times. An error of 5 in the exponent of t would alter τ by about 5 per cent.

At a time about $t = 10^{-75}$ sec. the minimal photon, which on the dynamical scale had a period of 2×10^9 years at any date, would have had an energy and frequency about 1,000 times greater than a planet-generating photon. If absorbed by a star of solar dimensions it would have been sufficient to split it into a pair the distance of which was large compared with their radii. In such a case the parent star could not have contained enough angular momentum to allow its progeny to move in circular orbits. Otherwise it would previously have broken up by centrifugal action. Hence the orbits of distant binaries would be expected to be very eccentric, as in fact they generally are. On this hypothesis the more widely separated binary stars were formed about $1–2 \times 10^{10}$ years earlier than the solar system, on the dynamical scale, in agreement with the arguments based on gravitation, which ascribe to them an age of the order of 10^{11} years.

To return to the solar system, it may be asked whether it was formed by the absorption of a single photon, or of several in succession. The analogy with an atom, now less striking than at the time of Bohr's original theory, suggests the former hypothesis, but the latter must also be considered. The formation of the solar system would appear to have been in principle unobservable, since any radiation with which it could have been observed would either have passed through it unaltered or destroyed it. However, the correspondence principle can be applied to events of this character. The primitive sun, containing the angular momentum of the whole solar system, had a period of rotation of the order of a day on the dynamical scale, or somewhat more if it was larger than at present on this scale, while Jupiter has a period of revolution of about twelve years. When the correspondence principle is applied to an atom, we find that the frequency of the absorbed radiation lies between those of the atom in its initial and final states. If this was so for the formation of planets, the period of the photon required to produce the solar system (or Jupiter alone) is of the order of a year on the dynamical scale, so its frequency was about 2×10^9 times that of the minimum photon, and the epoch of origin was, on the t scale, about 2×10^9 times that calculated above as a minimum. Alternatively, we might argue as follows. The planet-making photon was a train of electro-magnetic waves. A train with a suitable period would set up electro-magnetic oscillations in the sun, which might lead to the ejection of one or more planets. Given the size and physical state of the sun, the period would be calculable. It would probably be rather shorter than that calculated above on the correspondence principle. In either case a photon would be most likely to be absorbed if it approached in the direction of the solar axis.

Since $\nu = 10^{72}$, and if T be the corresponding period on the dynamical scale, while t is the epoch of formation of the solar system, $\nu = t_0/t\mathrm{T}$; hence if T is about a year, $t = 2 \times 10^{-63}$ sec. roughly, whence $\tau = -3{\cdot}7 \times 10^{11}$ years. If, on the other hand, the sun absorbed a number of photons (say 9 in all, in order to form the major planets with Pluto and the parent of the asteroids) the value of ν for Jupiter would be only slightly less, but that for Mercury would be about 10^{66}, while the values of T would not differ among themselves so much. In this case the origins of the various planets were strung out over a period of about 4×10^{10} years of dynamical time, while the larger satellites of the outer planets (but probably not those of the earth and Mars) could have been generated by photons absorbed by these planets at a still later date.

We must now consider the probable state of matter at this time. There could, of course, have been no radiation from atoms, nuclei, or electrons; and it is fairly clear that all matter was fully ionized, since any atomic systems would be ionized by thermal collisions, and free electrons would be unable to enter quantized orbits by emitting radiation. Thus stars formed by gravitational condensation could only lose the energy liberated in this process by emitting matter. Their radii would be those at which protons and electrons were just lost. Thus the solar radius on the dynamical scale might well have been ten times its present value. If so, the energy of the postulated photon must be diminished by a factor of 10, which would only decrease the dynamical date $-\tau$ by $4{\cdot}6 \times 10^9$ years. The planets would, however, lose a good deal of matter immediately on formation, so that their original mass was greater than at present. This would give a correction in the opposite direction, while tidal friction would give a smaller correction.

The planets remained gaseous for a very long stretch of dynamical time. About $t = 10^{-10}$ sec., loss of energy by radiation became appreciable, and by $t = 10^{-4}$ sec., or $\tau = -10^{11}$ years it was in full swing. By about $t = 10^{10}$ sec. or earlier, the planets had liquefied, and by $t = 10^{13}$ sec. or $\tau = -1{\cdot}5 \times 10^{10}$ years, the stars had contracted to normal stellar dimensions. These contractions were probably responsible for the origin of many close binary systems, of the moon, and perhaps of the asteroids. During more than 3×10^{11} dynamical years the planets were gaseous. I suggest that during this period most of them acquired days equal to their years, while the sun rotated in a period which was some sort of average of the planetary years. On contraction, angular momentum on the dynamical scale was conserved, and the days therefore shortened to their present lengths on the dynamical scale, except in so far as they were lengthened by the ejection of satellites and by later tidal friction. This would involve contractions of the radii by factors varying between about 20 and 100. The exceptions may be said to prove the rule. Uranus has a retrograde relation. Its satellites revolve at a high inclination to the ecliptic, and that of Neptune has a retrograde motion. It would seem that tidal friction did not complete its work on the outer planets. The other cases of retrograde satellites are probably better explained by capture.

Energy is generally thought to be liberated in stars by the breakdown of unstable nuclei generated by thermal nuclear collisions. At present the rate of liberation is limited by the number of effective collisions, and is thus roughly constant in dynamical time. In the remote past nuclear breakdown was the limiting factor; so the sun's radiation per dynamical year gradually rose to its present level, and has been fairly steady through geological time. Since through most of the history of the stars and planets in dynamical time nuclei of all kinds were effectively stable, but thermal collisions occurred, and moreover through a long dynamical period the minimum photons were capable of providing the energy for nuclear synthesis, it is suggested that the heavy elements, including the radioactive ones, were built up from hydrogen between the formation of the stars and the effective beginning of their thermal radiation.

If the solar system was generated by nine or more photon absorptions, most of the stars in our neighbourhood must have absorbed several photons, and produced planets. If it only absorbed one, the frequency of long-period binaries suggests that events of this type were not rare, so that our galaxy may include some hundreds of millions of planetary systems. If so, the field of biology is probably wider than has been suggested.

The galaxies have masses of the order of 10^{45} gm. This is the mass of a photon of period 10^{-92} sec., that is, of the minimum photon at $t = 10^{-92}$ sec. Even if the galaxies were originally particles of matter as closely packed as atomic nuclei, and therefore of rather less than the size of the sun, the energies needed to disrupt them into gas were considerably less than that of such a photon. Hence if the galaxies originated by the absorption of radiation, in which case some of Milne's 'fundamental particles' may still exist in a compact form, or even if their whole mass arose from radiation, they cannot date from before $t = 10^{-92}$ sec., or $\tau = -5 \times 10^{11}$ years. Thus the long time-scale of about 10^{12} years deduced from a study of gravitational interactions of stars, which are naturally measured in dynamical time, appears as a consequence of Milne's theory.

The above arguments must be regarded as the attempt of a layman to deduce some of the consequences implicit in Milne's cosmology, consequences which he had partly envisaged when he wrote in 1936 that "all dynamical theories of the origin of the solar system may require drastic revision". I have doubtless missed other consequences as important as any which I may have elicited. Even if my hypothesis is found to be logically coherent, it may well prove, when fully developed, to be as untenable as Laplace's nebular theory. In particular, the secular stability of non-radiating ionized gaseous spheres and the relation of the uncertainty principle to the scale of time will require investigation. Above all, the details of the postulated process were in principle unobservable, and it will therefore be hard to test the proposed theory as rigorously as others have been tested in the past. This is a serious defect, since the value of a scientific theory increases with the number of ways in which it can be tested. But much of current physical theory has the same defect.

I have not suggested an origin for the postulated photon or photons. To do so would involve either a further step in a possibly infinite regress or the assumption that they were primordial constituents of the universe. They might, for example, have been generated by the acceleration of large charges during the origin of the galaxies. It may be asked what is their present state, if any of them have not been wholly or mainly converted into kinetic energy. The energy of a photon is invariant on the kinematic scale appropriate to the particle emitting it; but since a particle absorbing it is moving away from its source, its frequency and energy are lowered by the Doppler effect, and on the kinematical scale appropriate to such a particle, both vary as t^{-1}, where t is the epoch of absorption. Thus the postulated planet-making photons are now trains of electromagnetic waves of a period of the order of a year, and much too small to be observable in practice. The mass of matter at any time is thus the fraction of the mass at an earlier time which has not been degraded by the Doppler effect, and at a sufficiently early date most of the mass of the universe, or all of it, may have been radiation rather than matter.

In conclusion, I wish to thank Prof. Milne for his encouragement, and for elucidating several details of his cosmology in letters, and to emphasize that if the theory here sketched has any value at all, it will only prove its value by serving as a basis for exact calculations by persons better versed than myself in physics and astronomy.

[1] "Problems of Cosmogony and Stellar Dynamics" (Cambridge, 1919). "Astronomy and Cosmogony" (Cambridge, 1928).

[2] "Relativity, Gravitation, and World Structure" (Oxford, 1935). *Proc. Roy. Soc.*, A, **154**, 22 (1936); **156**, 62 (1936); **158**, 324 (1937); **159**, 171, 526 (1937); **160**, 1, 24 (1937); **165**, 313, 333 (1937). *Phil. Mag.*, **34**, 73 (1943).

By Prof. E. A. MILNE, F.R.S.
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Prof. Haldane's idea as developed in the foregoing article seems to me to be fundamentally important. As all may not be familiar with the details of kinematic cosmology, and as readers may have difficulty in keeping pace with the rapier-like speed of Prof. Haldane's mind, I beg to be allowed to traverse some of the same ground in more pedestrian fashion.

To begin with, a word of explanation: I first announced my ideas on the two time-scales at the Blackpool meeting of the British Association, in a discussion on the origin of the solar system; but the consequences of the ideas were so bizarre that I felt it to be absolutely necessary to develop the formal and philosophical aspects of the theory in full detail before proceeding to the more speculative consequences. This programme I carried out in a series of papers published by the Royal Society during 1936–38, and, though hindered by war-work, in *Philosophy* (1941), in addresses before the London Mathematical Society (1939), the Royal Society of Edinburgh (1943), the Royal Astronomical Society (1944) and in a series of papers in the *Phil. Mag.* (1943). I am at present wrestling with the difficult problem of the conservation of linear momentum for gravitating bodies in the expanding universe, and I do not wish to be hustled. However, in *Proc. Roy. Soc.*, A, 165, 354 (1938), discussing the role of the correspondence principle on the two time-scales, I wrote: "It is not a fanciful speculation to see in the interplay of radiation keeping t-time with matter obeying the classical laws of mechanics on the τ-scale a phenomenon giving rise to the possibility of change in the universe *in time*, and so an origin for the action of evolution in both the inorganic and organic universes". A possible mode of that interplay has now been pointed out by Haldane.

I have long been aware that all theories of the origin of the solar system require drastic re-consideration in the light of the fact that at times of the order of $t = 0$, when the solar system was born, dynamical and optical conditions were very different. Haldane works with equal facility in either time-scale; but it must be remembered that the τ-scale is a concession to our Newtonian predilections, that it has in its description a constant t_0 (the present age of the system on the t-scale) which has nothing to do with *phenomena*; it has to do only with the language by which we describe the phenomena. Phenomena themselves are best studied through the t-scale, and in this scale the precise value of t at the epoch studied is all-important.

In Haldane's calculation of the order of magnitude of the energy required to be communicated to the

sun to form the solar system of planets, he uses the formula $\gamma mM/R$, with the present values of γ and R. It might be objected that on my theory $\gamma \propto t$, and that therefore the required energy was then much smaller. The answer is that $R \propto t$ also, that energy is a 'time-invariant', and that Haldane's calculation is accordingly correct. On his data, the value of $\gamma mM/R$ is 5×10^{15} ergs, as he says.

Previous speculators on the early history of the universe had always argued that since the universe is expanding, collisions must have been then more frequent, forgetting that lengths of material objects (that is, radii) would have then been much smaller. By translating to the τ-scale (stationary universe) we see that collisions would be just as frequent, or as infrequent, as now. The new contribution which Haldane makes is that the optical situation would be entirely different. At epoch t, when the radius of the expanding universe was ct, there cannot well have been photons of wave-length exceeding ct. The inequality $l < ct$ implies for the frequency n the relation $n = c/l > 1/t$. (Here l and n are measured on the t-scale.) Working again on the t-scale, the inequality $\Delta E = h_0 n > h_0/t$ gives the minimum permissible photon energy. Taking $h_0 = 6 \cdot 55 \times 10^{-27}$, at epoch $t = 10^{-72}$ sec., we get $\Delta E > 6 \cdot 5 \times 10^{45}$ ergs, so that such photons as were then possible would have sufficient energy to disrupt the sun and form a solar system.

There is no difficulty as to where the photons could come from. For according to kinematic relativity the mass (actual) and energy of the universe are infinite; and light must be present. Hence it must be, at small t, of enormous frequency and energy. The state of material atoms would be one of complete ionization; and the history of any photon would be one of successive degradations of frequency by interaction with matter, until at the present epoch light is *mostly* as we know it. This degradation of the individual photons due to interacting with matter must be distinguished from their constancy of frequency in time (t-scale) as they are propagated through empty space.

The epoch at which a photon ΔE was not less than $6 \cdot 5 \times 10^{45}$ ergs was, on the t-scale, 10^{-72} sec. The τ-measure of this epoch was $\tau = t_0 \log(t/t_0) + t_0$. The 'time ago' at which it occurred is $\tau_0 - t$, where τ_0, the present epoch on the τ-scale, is equal to t_0. This gives

$$\begin{aligned}\tau_0 - \tau &= t_0 - \tau = t_0 \log_e(t_0/t) \\ &= 6 \cdot 3 \times 10^{16} \times 2 \cdot 3 \times \log_{10}(6 \cdot 3 \times 10^{16}/10^{-72}) \text{ sec.} \\ &= 6 \cdot 3 \times 10^{16} \times 2 \cdot 3 \times 88 \cdot 8 \text{ sec.} = 4 \cdot 1 \times 10^{11} \text{ yr.},\end{aligned}$$

in agreement with Haldane. This is of the order of the 'long' time-scale estimated by gravitational methods, that is, on the τ-scale.

Haldane's fundamental idea (pressing it to its limit) may be stated in the form that, just as the epoch $t = 0$ is a singularity in the mechanical t-history of the universe—an epoch at which the density was infinite—so the epoch $t = 0$ is a singularity in the optical history of the universe, namely, an epoch at which the frequency of radiation was infinite, because the wave-length had to be zero. Actually we can only make significant statements about the radiation for *small* epochs t, when the frequency would on the whole be very large. A spectrum would soon come into existence, by the absorption and backward emission (or backward scattering) of radiation by the naturally receding particles, with resulting degradation of frequencies by the cumulative Doppler effects. But some of the original high-frequency radiation would traverse space unscathed, and, in spite of the inevitable Doppler effect at the terrestrial receiving end, a small fraction of this would retain a still very high frequency, and might be the origin of the undulatory component of the present cosmic rays.

I think it would be wise, in this preliminary discussion of Haldane's idea, not to go into details as to how a primordial photon of huge energy could disrupt a star. It is sufficient to dwell on the remarkable result that Haldane has deduced from kinematic relativity, namely, that at very early epochs in the history of the universe, such photons as there were must have possessed enormous energies.

WIREWORMS AND FOOD PRODUCTION

By HERBERT W. MILES
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WIREWORMS are undoubtedly the most notorious of all insects of agricultural importance, probably because their depredations are more extensive at times of agricultural expansion and prosperity. The traditional agriculture of Britain has been mainly the type known as 'mixed farming', and the measure of prosperity has been the extent of land under the plough. Wireworms are grassland insects, and so long as grassland is undisturbed they are of no economic importance. Periods of agricultural depression are periods of increasing areas of grassland, both cultivated and derelict, and consequently periods in which the numbers of grassland insects increase. Events that lead to high prices for cereals—the Napoleonic wars and the Corn Laws in the first half of the nineteenth century, and the German wars in the twentieth century—are associated with the ploughing up of grassland, and the enhanced value of the crops stimulates the interest of the farmer in the causes of crop failure. It is a simple proceeding to pull up dying plants, and only too frequently the expected wireworms are found at their roots.

In reports of the Board of Agriculture during the War of 1914–18 it was noted that in specified districts wireworms were responsible for the "complete destruction of cereal crops". Although it is doubtful whether wireworms caused all the loss imputed to them, the prospect of another European war and the consequent need for a great increase in cereal growing in Britain made imperative some reconsideration of the wireworm problem. The difficulties confronting the agricultural advisory entomologists were considerable. During the post-war years there had been little investigational work on wireworms, and their occurrence as a field pest had only been occasional in a period when cereal production was declining and little established grassland was being broken for arable culture. Farmers required advice and assistance long before the five-year period necessary for the observation of the wireworm life-cycle could be completed and while only the scantiest of information was available on the distribution of wireworms in the soil and the density of wireworm populations. The scale of the national ploughing policy and the speed with which it had to be carried out precluded the development of direct control measures aiming at wireworm destruction and compelled resort to modifi-

cation of agricultural practice and choice of crop to avoid loss through wireworm attack

How the wireworm problem has been dealt with is described in a recent publication of the Ministry of Agriculture and Fisheries[1]. The collaborators in the work were sixteen official entomologists with their staffs and a statistician Their primary task was to find a technique suitable for assessing wireworm populations on an extensive scale with reasonable speed and accuracy The study of soil fauna has been hampered by technical difficulties of extracting animals from soil. Wireworms vary in length from 1 mm to 20 mm., and unless soil structure is completely broken the smaller wireworms may be trapped in the soil aggregates The usual methods of extracting wireworms from soil are hand-sorting and flotation Hand-sorting has obvious limitations, particularly when the heavier types of soil are involved. Extraction by flotation presents difficulties regarding the transportation and disposal of soil, the need for special laboratory facilities and equipment, and the likelihood of cannibalism among wireworms in stored soil.

Circumstances compelled the adoption of hand-sorting as the standard method of wireworm extraction for war-time advisory work It was recognized that only the larger wireworms were found by this method ; but since they were mainly responsible for crop loss it was considered that hand-sorting revealed the effective wireworm population with reasonable accuracy. At some of the advisory centres where necessary facilities existed a flotation method of wireworm extraction was adopted ; but the greater efficiency of extraction was offset by the sacrifice of other detail The recognition of the limitations of the extraction methods used by the advisers led to the evolution by Salt and Hollick[2] of a mechanical means of extracting wireworms from the soil. This apparatus is designed for research work and should stimulate the study of soil fauna, since it affords for the first time a reliable means of separating from the soil minute insects and other creatures, insect and other eggs, and eelworm cysts.

Lack of information on both horizontal and vertical distribution of wireworms in the soil and on their seasonal movements complicated the problem of estimating wireworm populations, but statistical examination of series of numbers of wireworms from soil blocks of various sizes suggested that reasonable accuracy might be obtained by the examination of twenty more or less evenly distributed core-borer samples 4 in. in diameter and 6 in. deep. Sampling of this intensity involved the careful scrutiny of approximately a hundredweight of soil in each field (the average size of 34,000 fields was rather less than ten acres), and demanded a high standard of integrity on the part of field workers who often carried out the examination in the open in poor weather. The probable limits of error of population estimates calculated on the basis of such sampling is discussed in the bulletin, and the possibility of both under- and over-estimating had to be allowed for in formulating advice.

In making a survey of wireworm populations in grassland scheduled for ploughing in various parts of England and Wales, in conjunction with observations on crop performance in surveyed fields, the advisory entomologists hoped to obtain information on the distribution of wireworm population, the crop loss associated with various population densities, and the influence of such factors as geographical position, soil type, fertility and agricultural management on wireworm populations and crop loss. By the autumn of 1943 wireworm population estimates had been made on more than 34,000 fields, and the bulletin gives wireworm distribution maps showing that populations tend to be higher in the east and south-east and lower towards the west and north. The grouping of fields into those having 'high', 'medium' and 'low' wireworm populations was arbitrary, but it must have given confidence to farmers and war agricultural committees to know that in 50 per cent of the fields scheduled for ploughing wireworm populations were considered low and not likely to cause serious loss of crop.

Observations made in the course of the survey indicated that crop failure was the result of the complex interaction of a number of adverse factors, and only in about one field in six were wireworms sufficiently numerous to be a serious menace to crop production Such factors as soil conditions and fertility, the standard of cultivation and the use of good-quality seed protected from seed-borne diseases, were so important that where they were satisfactory good cereal crops could be produced in fields where the effective wireworm population was well in excess of a million per acre.

The survey has not revealed any reliable correlation between the level of wireworm population and soil texture, soil moisture, fertility and agricultural management, but it has shaken some widely accepted beliefs concerning the incidence of wireworms. Poor, undergrazed, badly managed grassland where coarse tufted grasses prevailed was thought to encourage wireworm development; but when counts were made it was found that wireworms were generally most numerous in good grassland, and some of the highest recorded populations were found in Romney Marsh and Leicestershire in some of the best permanent pastures in Britain. Light loams and sandy soils had been associated with severe wireworm injury, but the survey showed that in most counties higher wireworm populations prevailed in the heavier types of soil.

The success that has attended the remarkable expansion of arable cultivation fostered by the Ministry of Agriculture has been due largely to the close co-operation of farmers, technical agricultural officers and specialist advisers. Through the study of crop performance on newly broken grassland, the advisers in entomology have been able to suggest crops that might be successful on land heavily infested with wireworms, and to recommend modifications of farm practice, such as the adoption of heavier seeding-rates, that would assist the establishment of satisfactory stands of plants in spite of thinning by wireworms. The knowledge that scientific workers and agricultural technicians were deeply concerned with the problem of crop production helped to check a fatalistic attitude among farmers forced to adopt systems of farming for which they had neither the implements nor the experience, and the obvious success of arable crops in what were often considered unfavourable circumstances encouraged farmers to make the best of tools placed at their disposal, fertilizers that were available and their own skill and experience.

To those concerned with pest control on agricultural crops the survey has induced a more critical attitude to crop failure and placed increased emphasis on the importance of high standards of cultivation and fertility. Market garden and fruit crops have

a high intrinsic value, and are grown on a comparatively small scale, therefore expenditure on the destruction of insects and fungi attacking them is economically justified; but for farm crops, only indirect methods of dealing with pests and diseases are practical. Like the medical officers of health, the plant pathologists concerned with agricultural crops must study conditions in which disease occurs and aim at developing preventive rather than the much more costly curative measures. Wireworms are present in practically all agricultural land; but the farmer who can maintain satisfactory standards of fertility and husbandry will suffer little loss from moderate wireworm populations.

The problem of how to balance the necessary periods of rest under grass when wireworm populations increase, with periods under arable culture when they are dispersed, has still to be tackled. This is long-range work that will require comprehensive biological, ecological and insect physiological studies. The change from war-time to peace-time agriculture will provide the field conditions required for the work. The solution of this problem would assist in the establishment of a flexible agriculture and remove from the mind of the farmer the fear that the benefits accruing from resting land under grass would be dissipated by the depredations of wireworms.

[1] Bulletin 128 "Wireworms and Food Production" (H M Stationery Office. 1s.)

[2] *Ann. App. Biol.*, **31**, 52 (1944)

OBITUARY

Sir Buckston Browne

George Buckston Browne came of a line of medical men, he being a representative of the fifth generation. He was born on April 13, 1850, of wealthy parents, his father being Dr. Henry Browne, physician to the Manchester Royal Infirmary and lecturer on medicine, and his mother, Ann Hadfield. He was an only son; two sisters rose to eminence in the civic life of Manchester. His mother died while he was still in his boyhood; the father, who was deeply religious, and son drifted apart; it is customary to blame the Victorian father for the clash which separated son from father, but those who knew Sir Buckston in his later years will realize that the clash may have been due as much to the son's opinionative wilfulness as to the father's Calvinism.

However this may be, Buckston Browne, in 1866, when he was sixteen years of age, resolved to leave the paternal home; he asked for, and was given, an allowance of £3 per week with which to feed, clothe and educate himself. He had been at Amersham Hall School for four years and had passed the matriculation examination of the University of London. He went to London, resolved to carry out his boyish ambition of becoming a medical man. With this object in view he entered as a medical student of University College; he laboured day and night to make himself proficient in his profession; in 1873 he won by open contest the proud position of being 'house surgeon' to Sir John Erichsen. Then in 1874, at the age of twenty-four, he entered the world of 'incomes'; he had become a member of the Royal College of Surgeons; he augmented his paternal allowance by earning £8 a month by demonstrating in the dissecting room and coaching in anatomy at the rate of 2*s*. 6*d*. an hour.

It was at this juncture of his affairs that Buckston Browne engaged himself as private assistant to Sir Henry Thompson at the rate of £200 a year. Sir Henry was surgeon to University College Hospital, and recognized as the leading authority on all diseases of the genito-urinary system. At the time he entered into this contract with Sir Henry Thompson, he made a love marriage, choosing as his wife Helen Elizabeth Vaine, of Sparsholt, Hants He was often heard to declare that his success in his profession was due, not to his patron, but to his wife. It was a happy companionship which endured for fifty-two years, coming to an end in 1926 They had two children, a son and a daughter, the daughter became the wife of Mr. Hugh Lett, surgeon to the London Hospital—later Sir Hugh Lett, Bart., president of the Royal College of Surgeons; the son, George Buckston Browne, won the D.S O in the first World War, dying in 1919 from war service, leaving a son, the sixth George Buckston Browne, who died in 1924, the last of the male line.

The first period of Buckston Browne's professional life in the West End of London was spent in the service of Sir Henry Thompson and in laying the basis of his own practice. He had no hospital appointment to commend him; he had failed to pass the fellowship examination of his college; but he possessed a rare delicacy of manipulative skill and a profound knowledge of all ailments of the bladder, particularly those due to enlargement of the prostate. On Sir Henry Thompson's retirement, all such cases found their way to Buckston Browne's consulting rooms; elderly gentlemen who nowadays suffer from enlargement of the prostate submit themselves to the one major operation, but at the period with which we are dealing, they were educated to lead what was known as the 'catheter life' under the immediate care of their surgeon. Buckston Browne devoted himself to his practice so wholeheartedly that in less than forty years he had attained a financial success which has rarely been equalled in the annals of medical London.

Thus it came about that in the year 1927, Buckston Browne found himself a wealthy but lonely man; he had lost the companionship of his wife; his son and grandson were dead, his larger ambition, to participate in public life, was unsatisfied. In this year the British Association, meeting in Leeds, appealed for a fund which would enable it to purchase Darwin's home at Downe, Kent, and preserve it as a national memorial. Buckston Browne at once offered to provide the money needed. In his youth he had sat under Huxley at the School of Mines and had been a lifelong admirer of Darwin. The goodwill of the Darwin family made the purchase of Down House possible. He spent upwards of £10,000 on the restoration of the house and grounds, adding a gift of £20,000 for its upkeep. The British Association was thus able to open house and grounds to the public on June 7, 1929.

Buckston Browne then turned his beneficent activities towards his old college, the Royal College of Surgeons of England. On February 4, 1931, he addressed a letter to the Council of the College in which this sentence occurs: "I ask you to grant me the great privilege of building and endowing an Institution of Surgical Biological Research in which surgeons, particularly young surgeons, will have full opportunity for carrying out their investigations".

Ultimately, he conveyed stock to the value of £105,000 to carry out his scheme. He remembered

how essential John Hunter found his farm at Earl's Court to be for the completion of his experimental work, and hoped that the institution or farm he had in mind would serve young surgeons as an 'Earl's Court'. He bought land adjacent to the Darwin estate as a site for his institution, now known as the Buckston Browne Farm for Surgical Research. It was opened in 1933, but with the coming of war all its research workers were called to the field, the laboratories being taken over by the Emergency Health Service. With the return of peace we may hope to see it restored to its old activities.

Among his intimate friends Buckston Browne numbered Sir Thomas Barlow: both were from Lancashire; they met as students at University College; they occupied houses in Wimpole Street which faced each other. On January 11, Sir Buckston was carried to his old hospital, suffering from a fracture of the neck of his femur; he died on January 19, well advanced into his ninety-fifth year. As he lay in the hospital, where seventy-three years before he had been house surgeon, his senior friend shook off the burden of life, having reached his hundredth year.

In 1931 the University of Aberdeen conferred its honorary LL.D. on Sir Buckston in recognition of his services to surgery. In 1932 he received the honour of knighthood, when he discarded "George" from his name, wishing to be known as Sir Buckston Browne.

A. Keith.

In *Nature* of October 28, 1944, an obituary notice was printed of Prof. Gustav Gilson: we have since been informed that Prof. Gilson died on January 1, 1944.

NEWS and VIEWS

Anglo-French Society of Sciences

At the beginning of the War, a number of scientific men in England and France became conscious of the lack of close knowledge and contact between the science and scientific workers of the two countries. As a result, they founded in April 1940 an Anglo-French Society of Sciences to assist the removal of this lack of mutual knowledge. The Society was organized in two groups, under the presidencies of Prof. P. A. M. Dirac and Prof. F. Joliot. The occupation of France interrupted normal proceedings, but during the occupation some members became very prominent in the French resistance movement. The liberation of France has enabled the Society to hold its first conference, which was on the topic of "The Solid State", and was held in London on January 20 at the Society for Visiting Scientists. Prof F. Joliot and Mme. Irene Curie-Joliot travelled from France to take part in the proceedings, and were accompanied by Prof. Wyart, Dr. J. Laval and Dr Mathieu. Papers were read at the conference by Prof. N. F. Mott, Sir Geoffrey Taylor, Dr. Laval, Dr. Mathieu, Dr. Guinier, Prof. Wyart and others.

Members of the Society were entertained to tea at the House of Commons by Sir Robert Bird, chairman of the Anglo-French Parliamentary Committee. In reply to speeches by Sir Robert Bird and Mr. E. W. Salt, chairman of the Parliamentary and Scientific Committee, Prof. Joliot spoke on the contribution of science to international understanding, and its place in the conduct of affairs. Science tends to clarity of mind and rational method, and it should be introduced into all aspects of a nation's life, including many where it may not hitherto have been customary. Prof. J. Hadamard referred to David Hume's famous remark that British soldiers fight and die in order that British judges may judge according to their conscience; the devotion of the English and French to that ideal is a binding link between them.

Medical Education in Great Britain

In a reply on January 18 to a question in the House of Commons regarding the Goodenough Report on Medical Schools, Mr. Willink stated that the Government recognizes the fundamental importance of medical education and research to the future of the health services of the country, and accepts the principle of increased grants for the purposes of medical education and research to be distributed by the University Grants Committee through the universities to medical schools, postgraduate schools and institutes and hospitals used for teaching and research. The Government also accepts the suggestion that for a limited period these additional grants should be separated from the block grants received by universities for their work as a whole. As regards the views expressed in the report on the importance of affording to women equal opportunities to those enjoyed by men for medical training and for obtaining postgraduate experience, the Government has decided that future payments of grants to medical schools should be conditional on the adoption by the school of the principle of admitting a reasonable proportion of students of both sexes. It is proposed also that the University Grants Committee, in consultation with the university authorities concerned, should be responsible for determining from time to time whether the action taken by each of these schools complies reasonably with the principle. Equal importance is also attached to the revision of the medical curriculum, and acceptance of the principle of increased grants for medical education and research depends on the early completion of such a revision.

Tuberculosis Mortality in the United States

According to J. Yerushalmy, principal statistician, H. E. Hilleboe, senior surgeon, and C. E. Palmer, surgeon, United States Public Health Service (*Public Health Rep.*, **58**, 1457; 1943), the average annual number of deaths from all forms of tuberculosis in the United States in the period 1939–41 was 10,429 (45·9 per 100,000 of the population). Mortality from tuberculosis was 41 per cent higher among males than among females, and three and a half times as high among non-whites as among whites. Death-rates for all forms of tuberculosis were higher in the older age-groups than in the younger. Among children and young adults the rates were higher for females than for males; but in the older groups the rates were much higher for males. Nearly one half of all tuberculosis deaths occurred at the ages 20–44. The death-rate from tuberculosis for males was higher among residents of large cities than among residents in intermediate sized cities, and that of the latter was much

higher than the rate for residents in rural areas. Tuberculosis mortality has decreased continuously since the beginning of the century, the rate in 1941 being less than one fourth that in 1900, and has fallen at a greater rate than mortality from all causes.

Commercial Fish Catch of California for 1941 and 1942

Fish Bulletin No 59 of the California Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries (1944), by the staff of the Bureau, contains detailed records of fish delivered by commercial fishing boats to Californian ports. In addition, shipments of fresh fish by truck, rail or cargo vessel to Californian factories from outside the State are included. There is much information in this report. The value of all landings is tabulated, the 1942 values reflecting the higher war prices and price-ceilings fixed by the Federal Government. Although the value is much increased, the weight in pounds is less. The decrease in volume of the 1942 catch was due to reduced numbers of the better class of fishing boats and of experienced fishermen, as well as to the restrictions placed upon the free movement of fishing vessels necessitated by Army and Navy coastal defence plans. The sardine, *Sardinopsis cœrulea*, heads the list both in weight and value; the Pacific mackerel, *Pneumatophorus diego*, and the yellow tuna, *Neothunnus macropterus*, coming next. Various shell-fish occur in much smaller numbers. It is interesting to note that crabs (*Cancer magister*) average 2 lb. each and abalones (*Haliotis* spp.) 50 lb. per dozen. A useful list of common and specific names of fishes, crustaceans and molluscs is given.

Soil Conservation in Kenya

In his first broadcast, on December 27, since he assumed office as governor of Kenya, Sir Philip Mitchell dealt with one of the Colony's most pressing problems—soil erosion. He illustrated his talk by reference to the Ukamba Reserve, where the far-advanced state of soil deterioration is causing grave anxiety. Here, Sir Philip said, is a salvage job which must be put in hand immediately. Much useful agricultural engineering work has already been done, but work needs to be greatly accelerated, otherwise "in a few years time there will be nothing left of the Ukamba Reserve". Concurrently, a social reorganization leading to a changed attitude of the African to his land must be carried through. Sir Philip sees most hope for soil conservation in the establishment of a landlord-tenant relationship, the landlord being the tribe as a whole, and the tenant the head of the family. Such a system would ensure the greatest possible security of tenure for the good cultivator and none for the incorrigible land miner. But he sees no short cut to the ultimate goal of restoring the land to a state of stable fertility.

Merseyside Naturalists' Association

The third war-time portfolio of the Merseyside Naturalists' Association, an attractively bound volume of two hundred and fifty pages comprising sixty-five pages of photographs and coloured plates and forty-three original articles, has been edited by Miss J. Linaker. It includes detailed accounts of regional bird-life at Mold, North Wales, by J. Lord and C. Swaine; Wigan and Leigh flashes, by G. Brown and T. Edmondson; Hoghton, by G. C. Miller; a Mersey shore pool, by F J. Hartley; St Andrews, the Midlands and war areas of Italy and North Africa. the president, Philip Ashcroft, describes his researches into the history of Martin Mere, the lake of 3,000 acres that once covered west Lancashire, Eric Hardy has a detailed account of the extinct and earliest known fauna of the north-west of England, and Mrs. E G. Hardy describes how nestling hedge-sparrows were killed by a colony of brown ants There is much that is of more than local interest. The raven is increasing its nesting range on the North Wales border, the cirl-bunting has definitely been established as a nesting bird in west Lancashire, while the colliery subsidence waters of south Lancashire are now known to be an important passage haunt of several rarer ducks, waders and wild swans.

Bibliography of Seismology

The *Bibliography of Seismology*, 13, Nos 14 and 15, Items 5564 to 5787, July 1943–June 1944, published by the Dominion Observatory, Ottawa, Canada, have just been received In them are listed in full, occasionally with comments, papers and books from all parts of the world except Germany and Japan, dealing with pure and applied seismology. An interesting article listed in No. 14 is item 5579 by Centano-Grau, M., "Estudios sismologicos", Litografia del Comercio, pp. 555, 2 maps, 5 tab, Caracas, 1940, which gives a comprehensive review of many phases of seismology, and puts forward a theory of electrical causes for earthquakes of volcanic origin The book contains a complete catalogue of earthquakes of Venezuela, and a study of the destructive shocks, including predictions of probable recurrences in different regions. In Nos. 14 and 15 numerous papers are listed dealing with rock bursts, chiefly in Canada and South Africa One important paper is by Ernest A. Hodgson, "What is a Rock Burst?" published by the *Northern News*, Kirkland Lake, September 9, 1943, after a radio talk by the author. Other papers are by J. Spalding and include such topics as "Description of a Rock Burst", "Theory and Practice of Ground Control", and "Theory of Rock-Pressure" (Kolar Gold Fields Mining and Metallurgical Society Bulletins, 8, No. 41, 153, Johannesburg, 1935–37). An interesting theoretical topic is listed as item 5709 in No. 15 Finch, R. H., "The seismic prelude to the 1942 Eruption of Mauna Loa" (*Bulletin Seismological Society of America*, 33, No. 4, 237, 1943). The paper presents evidence that the eruptions of Mauna Loa are preceded by pronounced seismic activity, but that this activity falls off for a month or more prior to the actual eruption This paper may be considered a sequel to Harry O. Wood's paper in the same journal in 1915 on the 1914 activity. Items from *Nature* are listed in both parts of the bibliography.

Announcements

Prof. J. M. Mackintosh, professor of public health in the University of London and dean of the London School of Hygiene and Tropical Medicine, has been appointed a member of the Fuel and Power Advisory Council.

Dr. J. G. Davis, of the National Institute for Research in Dairying at Shinfield, near Reading, has been appointed scientific adviser to the Express Dairy Co., Ltd., London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications.

Nitrogenous Substances Synthesized by Moulds

DURING investigations on nitrogen-containing materials synthesized by moulds, we have isolated, in high yield, from the mycelium of *Penicillium puberulum* Bain., a hitherto undescribed organic substance This substance, which exists in white and yellow forms, is photosensitive, analyses as $C_{17}H_{12}N_2O_2$, and melts with decomposition at 220°. Two enolic hydroxyl groups appear to be present, since reaction with diazomethane gives a dimethyl derivative, m p. 181° (decomp.), which contains no N-methyl groups. This material crystallizes in two interconvertible forms, either as yellow needles or as bronze-brown plates, from acetone. Acetylation of the original substance with acetic anhydride and pyridine yields a diacetyl derivative, m p 226° (decomp.). On heating, the original substance yields phenol, and oxidation gives *p*-hydroxy-benzoic acid Oxidation of the dimethyl derivative with permanganate yields hydrogen cyanide, anisic acid and other unidentified products, and heating with sodium methoxide in methyl alcoholic solution gives ammonia, anisic acid and other products.

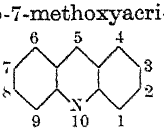
Both the original substance and its acetyl and methyl derivatives give blue-violet fluorescent solutions and possess characteristic absorption bands. The original substance shows bands at 243 mμ and 374 mμ with log $\varepsilon_{max.}$ 4·08 and 4 60 respectively in ethyl alcohol. The dimethyl derivative possesses very similar absorption spectra with bands at 240 mμ and 371 mμ, with log ε_{max} at 4·12 and 4·54 respectively in the same solvent. The acetyl derivative has absorption bands at 232 mμ and 334 mμ, with log ε_{max} 3·79 and 3·84 respectively. In alcoholic alkaline solution the spectrum of the dimethyl derivative is unchanged, but the original substance now possesses bands at 436 mμ, 398 mμ and 252 mμ with log ε_{max} 4·59, 3·98 and 4·09 respectively.

The original substance has antibiotic properties, and does not appear in the mycelium until incubation has proceeded for five weeks. This aspect is receiving further attention, and other moulds are being examined for the presence of complex nitrogenous substances.

A. H. CAMPBELL. E. L. HIRST.
M. E. FOSS. J. K. N. JONES.
The University, Bristol. Dec. 5.

Optical Activity of Excreted Mepacrine

THE antimalarial drug mepacrine—2-chloro-5 (δ-diethylamino-α-methylbutyl)amino-7-methoxyacridine, acridine being numbered



—has been resolved by Cholintsev and Osetrova[1], who obtained $[\alpha]_D = \pm 195°$ for the free base and $[\alpha]_D = \pm 357°$ for the dihydrochloride.

In co-operation with the Army Malaria Research Unit in Oxford, we have recovered mepacrine from human urine and find that the excreted drug is apparently entirely the levo isomer. Thus we obtain, for the free base in methyl alcohol, $[\alpha]_D = -150°$ and $-207°$ (mean $[\alpha]_D = -179°$), the specimens having been separated chromatographically directly from urine on alumina. For the dihydrochloride, extracted from alkaline urine with ligroin, followed by chromatographic separation and elution with hydrochloric acid, values of $[\alpha]_D = -364°$ and $-372°$ (mean $[\alpha]_D = -368°$) were obtained.

We take this opportunity to correct the naming of the degradation product of mepacrine previously reported[2] as sometimes occurring in human urines, the substance should be described as 2-chloro-5-amino-7-hydroxyacridine

D LL. HAMMICK.
W. E. CHAMBERS.
Dyson Perrins Laboratory, Oxford. Dec. 23

[1] *J Gen Chem U S S R* 1928 (1940)
[2] *Nature* **154**, 461 (1944)

Hydrolysis of Thioesters

THE alkaline hydrolysis of triphenylmethyl thiobenzoate or α-benzoylbenzhydryl thiobenzoate[1] in alcoholic sodium hydroxide gave the corresponding thiol and benzoic acid,

$$\text{Ph.COS}R + \text{NaOH} \rightarrow \text{Ph.COONa} + R\text{.SH}.$$

But the acid hydrolysis of triphenylmethyl thiobenzoate (1·2 gm. in 200 c.c. alcohol and 30 c.c. conc. hydrochloric acid and boiled for 15 minutes) gave triphenylmethyl carbinol and thiobenzoic acid (separated and identified by oxidation to the disulphide):

$$\text{Ph.CO.S.CPh}_3 + \text{H}_2\text{O} \xrightarrow[\text{15 min}]{\text{HCl}} \text{Ph.COSH} + \text{Ph}_3\text{COH}.$$

The same procedure with α-benzoylbenzhydryl thiobenzoate but with a prolonged heating for two hours gave benzoic acid and the thiol.

$$\text{Ph CO.S.CPh}_2\text{.COPh} + \text{H}_2\text{O} \xrightarrow[\text{2 hr}]{\text{HCl}} \text{Ph.COOH} + \text{Ph.CO.CPh}_2\text{.SH}.$$

The mechanism suggested by Davies and Evans[2], if applied here, should give benzoic acid and the thiol in both cases. This result also shows that in acid hydrolysis of esters the OH of water does not necessarily appear in the acid molecule[3]; its position seems to depend on the anionic and cationic natures of the two radicals of the ester.

Further work is being continued by Iskander and Fateen.

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Chemistry Department, Faculty of Science, Farouk I University, Alexandria.

[1] Schonberg and Iskander, *J. Chem Soc*, 92 (1942).
[2] *J. Chem. Soc*. 444 (1940).
[3] Cf. *Annual Report Chem Soc.*, 229 (1940)

Structure of Colchicine

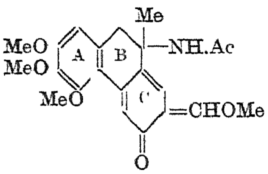
IN view of the remarkable physiological properties of colchicine its chemical nature is of some interest. Until recently, the structure (I) proposed by Windaus[1] has been generally accepted, although the stability of colchicine did not suggest a 9-amino-9 : 10-dihydrophenanthrene system, and although the salicylaldehyde enol structure of ring *C* appeared fantastic. Cohen, Cook and Roe[2] have now provided evidence that ring *B* must be 7-membered, but the exact

location of the acetamido group remains uncertain; the isolation by Windaus of 4-methoxyphthalimide from the oxidation product of acetylcolchinol methyl ether suggested that the group was adjacent to ring *C*, but Lettré and Fernholz[3] have found that only β-anisylethylamine derivatives act as mitosis poisons.

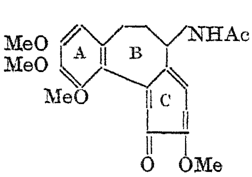
Windaus based his structure for ring *C* on the following evidence. (1) Colchicine is easily hydrolysed to methanol and colchiceine, which, unlike colchicine, gives an intense ferric chloride reaction. (2) Further hydrolysis gives acetic acid and trimethylcolchicinic acid. Trimethylcolchicinic acid forms a dibenzoate and two isomeric dibenzenesulphonates, which are hydrolysed to the same monobenzene-sulphonate. It cannot, therefore, be a carboxylic acid. Windaus thought the isomers were *cis* and *trans* hydroxymethylene derivatives. (3) With sodium hydroxide and iodine, colchiceine is converted to N-acetyliodocolchinol, in which ring *C* is definitely benzenoid. Similar reaction occurs with bromine water, while alkali fusion of colchicine followed by permanganate oxidation provides trimellitic acid, formed from ring *C*. (4) In alcohol, colchicine will form a deep yellow dihydrochloride, and its solutions in alkali are also yellow; salicylaldehyde shows similar behaviour.

On the other hand, it is very difficult to believe that colchiceine could also have the enolic structure. It certainly is not the isomeric aldehyde; the absorption spectra of colchicine and colchiceine are almost identical[4], and colchiceine is a much stronger acid than salicylaldehyde; it gives no carbonyl or aldehyde reactions. No double bonds can be detected in colchicine with maleic anhydride or perbenzoic acid[4].

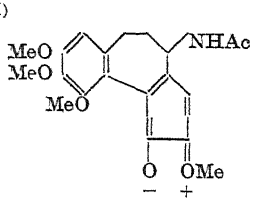
Recently[5], it was pointed out that stipitatic acid probably contains a tropolone ring; its reactions[6] seem closely analogous to those of ring *C* in colchicine and led to similar difficulties. The structure (II) is therefore now proposed for colchicine, resonance with (III) accounting for its stability; the system is analogous to γ-pyrone.



(I)



(II)



(III)

The facile conversion to benzene derivatives is due to benzilic acid rearrangement; analogies are provided by the Wallach degradation of cyclic ketones and the isomerization of stipitatic acid by alkali fusion. The intense ferric chloride reaction of colchiceine is at once explained, and also the existence of two isomeric dibenzenesulphonyl derivatives. It is interesting to observe that Lettré and Fernholz appear to have obtained a colchicine isomer by the action of diazomethane on colchiceine, although with sodium methoxide and methyl iodide colchicine is formed[7]. The formation of coloured salts with acid or alkali is characteristic of both colchiceine and stipitatic acid; also the slight colour of stipitatic acid suggests that, like colchiceine, it has an absorption band in the near ultra-violet.

It is hoped to confirm the structure (II) by lead tetra-acetate or analogous oxidation of hexahydrocolchiceine[4], which should on the new formulation be an α-glycol. Of course, in (II) the methoxyl and keto groups in ring *C* may be interchanged, or the ring rotated about its junction with ring *B*; further degradation will be required to establish the exact orientation of the various substituents.

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[1] Windaus, *Annalen*, **439**, 59 (1924)
[2] Cohen, Cook and Roe, *J. Chem Soc*, 194 (1940)
[3] Lettre and Fernholz, *J physiol Chem* **278** 175 (1943)
[4] Bursian, *Ber*, **71**, 245 (1938)
[5] Dewar, *Nature*, **155**, 50 (1945)
[6] Birkinshaw, Chambers and Raistrick, *Biochem J*, **36** 242 (1942)
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Extensive Penetrating Showers

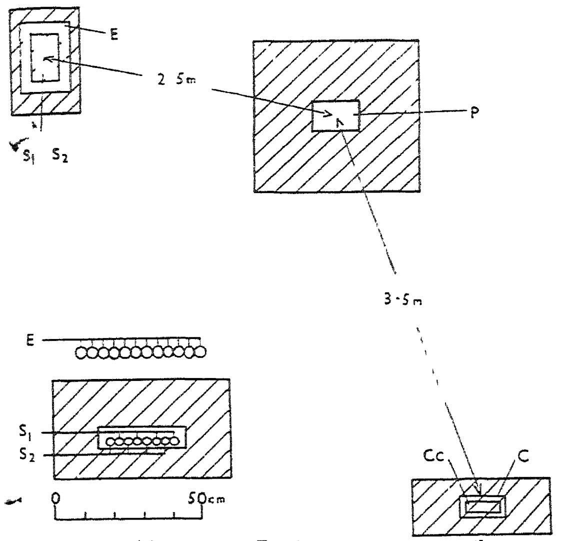
Two main types of cosmic ray showers have been much investigated: (1) extensive air showers (Auger showers); (2) penetrating showers. Extensive air showers can be interpreted, according to Euler and Wergeland[1], Nordheim[2], and Bethe[3], in terms of large electron cascades. Penetrating showers are probably produced by the process which is responsible for the production of the meson component of cosmic radiation.

It has been assumed that the two types of showers are connected. Thus Wataghin, de Souze Santos and Pompeia[4] and Jánossy[5] have found that the discharges in a distant counter often occur simultaneously with the discharge of a set of counters which record penetrating showers. Wataghin[6] and his co-workers have found showers with counters shielded with 17 cm. of lead at counter separations of 120 cm.

Auger[7] and Hilberry[8] have found that 5 per cent of extensive air showers can penetrate a lead absorber 10 cm. in thickness. Such a penetrating power cannot be expected for ordinary cascades. Rogozinsky[9] has also demonstrated the presence of penetrating particles in air showers.

These observations have usually been interpreted on the assumption that extensive air showers are, in the main, cascade showers which occasionally contain penetrating particles. From this experimental evidence and from the results of our own experiments, which are reported below, we would suggest a different interpretation, namely, that extensive air showers consist of two distinctly different types of showers: (1) large electron cascades which may contain a few mesons (Auger showers); and (2) extensive penetrating showers which have a large density of penetrating particles. These penetrating particles are probably accompanied by soft secondary particles.

The experimental lay-out is shown in Fig. 1*b*. It consists of two penetrating shower sets *P* and *C*, similar to those described elsewhere, and an extension *E* which is shown in detail in Fig. 1*a*. The counter tray *E* has an area of 2,500 cm.^{2} and the tray *S*, which is covered on the top and the sides by a layer of lead some 15 cm. in thickness, an area of 1,000 cm.^{2}. This tray consists of eight counters in two groups S_1 and S_2 of four counters each. The penetrating shower sets *P* and *C* require at least two penetrating particles



(a) Fig 1 (b)

to set them off. The set C is placed above and below a cloud chamber Cc (Rochester[10]). The data presented here are mainly for coincidences between the set P and the extension.

The following types of coincidences have been recorded. (1) Coincidences between P and at least one of the counters in the tray E (designated PE). (2) coincidences PE accompanied by the discharge of at least one of the counters of the tray S (designated PES), and (3) coincidences PE accompanied by the discharge of at least one counter in each group in tray S (designated PES_{12}). Thus showers of type (2) contain at least one penetrating particle at the extension, while showers of the type (3) contain at least two penetrating particles at the extension. The observed rates are given below :

EXTENSIVE AIR SHOWERS CONTAINING AT LEAST TWO PENETRATING PARTICLES NEAR P AND AT LEAST n PENETRATING PARTICLES NEAR THE EXTENSION

	$n = 0$ (PE)	$n = 1$ (PES)	$n = 2$ (PES_{12})
Count	152	37	17
Rate per hour	$0{\cdot}10 \pm 0{\cdot}008$	$0{\cdot}024 \pm 0{\cdot}004$	$0{\cdot}011 \pm 0{\cdot}003$

The rate of coincidences P, found from a separate experiment, is 0·24 c.p.h.

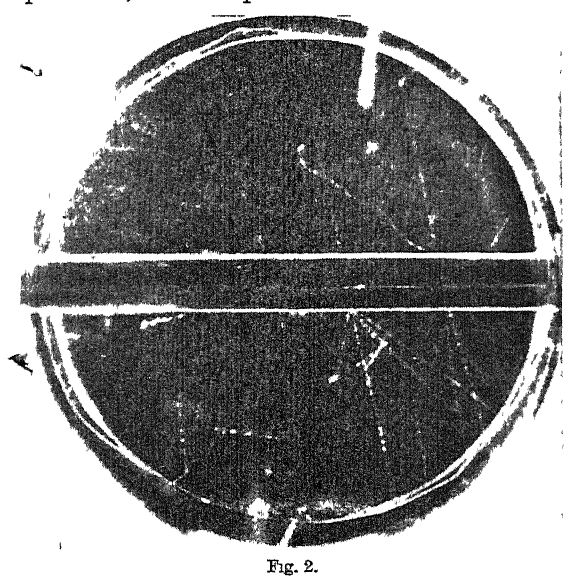


Fig. 2.

To produce coincidences PES_{12}, at least four penetrating particles are required. The probability that a shower of only four particles will simultaneously discharge counters in the P set and in the trays E and S_1 and S_2 is, however, extremely small. It is, in fact, so small that if all the mesons falling on an area of 30 m.^{2} around P and E consisted of showers of four mesons, the total number of such showers would still be far too small to account for the observed rate of extensive penetrating showers. Thus the density of the showers must be very much greater than four penetrating particles per 30 m.^{2}. An estimate of the lower limit of the density can be obtained by comparing the rate of coincidences PES with those of the type PES_{12}. It is concluded that the showers contain about twenty penetrating particles per m.^{2}, so that the number in the area 30 m.^{2} will be about six hundred.

It will be shown elsewhere that penetrating showers of this size and density cannot be accounted for in terms of meson production by photons or electrons in large showers.

Extensive penetrating showers cannot be accounted for in terms of the theory of Hamilton, Heitler and Peng[11,12]. According to this theory, groups of about ten mesons are to be expected whenever a fast nucleon traverses a nucleus. The mean-free-path of a fast nucleon in air much exceeds 100 m. Thus meson showers will be produced only rarely at distances smaller than 100 m. from the recorder. Showers containing about ten particles starting at such distances have an extremely small probability of setting off the recorder. Other processes giving rise to many more particles are therefore required to account for the observed coincidences. Such processes may include those enumerated by Hamilton, Heitler, and Peng, which become important above 10^{12} e.v.

We have obtained several photographs with the cloud chamber Cc (Fig 1) set off by coincidences PE. Some of these photographs show single penetrating particles. One photograph (Fig. 2) has been obtained for which a coincidence PES_1 (S_2 not discharged) occurred simultaneously with a coincidence of the set C. This photograph shows two particles passing through a lead plate 2 3 cm. in thickness placed across the chamber. As both particles produce secondaries in the lead plate, the incident particles cannot have been mesons. This photograph, though not necessarily typical of extensive penetrating showers, serves to show that such showers may be complex.

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G. D. ROCHESTER.
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Physical Laboratories,
University,
Manchester, 13.
Dec. 12.

[1] Euler, H., and Wergeland, H., *Astrophysica Norv*, 3. 165 (1940)
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[10] Rochester, G. D., *Nature*, **154**, 399 (1944)
[11] Hamilton, J., Heitler, W, and Peng, H. W, *Phys. Rev.*, **64**, 78 (1943).
[12] Jánossy, L., *Phys. Rev.*, **64**, 345 (1943).

Are there Four Possible Diamond Structures ?

SIR C. V. RAMAN has recently[1] made the suggestion that four different crystal structures of diamond exist, in which the carbon atom positions are similar, but in which the orientations of the tetrahedral carbon atoms in the two interpenetrating face-centred lattices differ. Two of these structures are tetrahedral, two octahedral ; Raman suggests that type I diamonds consist of either of the tetrahedral forms, or of both interpenetrating (the deviation from the 'ideal' crystal increasing with interpenetration), and that type II diamonds consist of either or both of the octahedral forms , mixtures of tetrahedral and octahedral forms, he suggests, may also exist.

This is a startling theory, for it implies the existence of a number of allotropic forms of all crystals of carbon compounds; but Raman supports his theoretical speculations with a wealth of interesting experimental evidence. His claim, however, that "X-ray findings leave the question whether diamond possesses tetrahedral or octahedral symmetry entirely open" cannot be left unchallenged. In the two *tetrahedral* structures postulated, the carbon atoms having co-ordinates 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ are similar in orientation and there should therefore be no second-order reflexion from the octahedral plane In any mixture of these structures, whether on a basis of time or space, the 222 reflexion must similarly be absent. In the two *octahedral* structures the atoms at 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ differ in orientation, and a weak 222 reflexion is to be expected.

The existence of a real (Bragg) 222 reflexion is not easy to demonstrate. It may be masked by the Renninger effect[2] (an effect due to multiple reflexion in the crystal, which produces apparent reflexion from planes which really cannot reflect at all, and which may enhance or diminish the reflexion from those that can), and it might be simulated by a vibration of the atoms that would disturb the 3 : 1 spacing relationship in the octahedral planes. In 1937, Renninger himself showed, however, that three diamonds of a wide range of texture all gave a real 222 reflexion in orientations where the Renninger effect could not occur[3]. One of his diamonds was a magnificent natural octahedron, the description of which classes it without doubt as an almost ideal type I. This gave a half-width at half-maximum 222 copper $K\alpha_1$ reflexion which was about one twelfth of the $\alpha_1 - \alpha_2$ separation, clear proof that it was a true Bragg reflexion from an almost perfect crystal.

I have examined a beautiful, water-white octahedral plate from Sierra Leone, kindly lent to me by Prof. W. T. Gordon; almost non-luminescent in ultra-violet light ; blue-luminescent in X-rays ; opaque beyond 3000 λ ; optically isotropic ; giving intense groups of 'extra' X-ray reflexions and showing no divergent-beam photograph at all ; it is obviously a near-ideal type I specimen. This gives a definite 222 reflexion in an orientation which forbids a Renninger effect, and the nature of the reflexion shows that it cannot be due to atomic vibration[4]. It proves conclusively that the structure is *not* tetrahedral, but that a real variation of orientation exists between carbon atoms in the 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ positions.

On the X-ray evidence, therefore, Raman's theory, that type I diamonds are essentially *tetrahedral* in structure, breaks down. It may also be noted that the 'tetrahedral structure' theory offers no explanation whatever of the peculiarities of the 'extra' reflexions, particularly for {220} {113} and {331}, in type I diamonds[5].

Dr. R. S. Krishnan[6] has supported Raman's theory that type II diamonds showing strong birefringence are really mixtures of *two distinct octahedral* structures, by suggesting that in such diamonds 'lattice constant' variations exist, of the order of 1 in 2,000. He states that my divergent-beam precision measurements of the diamond spacing[7] give only a mean value, and could not distinguish the existence of such variations This is not so. The sharpness of the absorption lines in my photographs (particularly for the high-order reflexions) shows that in the type II specimens used, the lattice constant did not vary by more than about 1 in 50,000, except possibly in regions so small as to give no observable X-ray effects. Krishnan bases his suggestion of a 1 in 2,000 spacing variation on the experimental fact that when a particular, optically anisotropic, lamellated type II diamond was correctly orientated for X-ray reflexion from the octahedral plate surface, the 111 reflexion recorded on a photographic film some 40 cm. away was wavy instead of linear, thus showing apparent variations in the value of θ, the reflecting angle. But this is a common phenomenon, and is capable of an altogether different interpretation. A slight distortion, in this case a corrugation, of the crystal surface, would cause an ex-centring of parts of the reflecting regions relative to other parts, quite sufficient to cause the observed waviness of the reflexion line.

There is a simple way of testing whether an apparent variation in spacing is real, or is due to ex-centring of parts of the reflecting surface. Diamond gives some fairly intense high-order reflexions ; and if these are examined, *crystal distortion* will give an angular variation of the same order as, or less than, that found for low-order reflexions ; but a *variation in spacing* would cause a much wider variation of reflexion angle. For example, the angular variation in θ_{111} (copper $K\alpha_1$) corresponding to a lattice variation of 1 in 2,000 would be only 0·7 minutes ; for θ_{331} (copper $K\alpha_1$) it would be 4·8 minutes , and for θ_{224} (zinc $K\alpha_1$) it would be 10·1 minutes. I have taken divergent-beam photographs of type II diamonds which give wide absorption lines, using copper K radiation. If the width were due to lattice spacing variation, the high-order absorption lines would be much wider than the low-order lines, but they are, in fact, not so wide. It is quite clear in the case of those diamonds that I have tested, that while distortion may sometimes occur, there is no X-ray evidence, on the basis of lattice constant variations, for the existence of the various structures postulated. The variation of the *texture* of the diamond, from ideal to mosaic, is of course a common feature of crystals generally[8,9].

KATHLEEN LONSDALE.
Royal Institution, Albemarle Street,
London, W.1. Dec. 11.

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British Bees and Wind-borne Pollen

It is well known that the perianth in wind-pollinated plants is lacking or greatly reduced and inconspicuous, that nectar-secreting glands are absent and that immense quantities of pollen are produced compared with entomophilous flowers. Furthermore, the individual pollen grains are more suited to carriage by wind, with their thinner walls and simpler form lacking spines or surface sculpture. They have a markedly lower specific gravity and do not cohere *en masse* like those of insect-fertilized flowers. It is therefore rather surprising to find that solitary bees of the genus *Andrena* sometimes collect large quantities of anemophilous pollen, for example, *Quercus*, *Fagus*, *Castanea*, as the analyses per cent of individual pollen loads taken off the species named below demonstrate :

A hæmorrhoa (Fab)

1		2		3	
Quercus	83	*Fagus*	82 2	*Fagus*	88 7
Ranunculus	8	*Taraxacum*	13 0	*Bellis*	7 7
Crataegus	6	Cruciferæ	3 8	Others	3 6
Acer	3	Others	1 0		

A armata (Gmelin)

4		5		6		7	
Quercus	90 6	*Quercus*	56 3	*Quercus*	56 7	*Quercus*	97 1
Viburnum	9 4	*Acer*	28 6	*Acer*	41 3	*Ilex*	2 9
		Ilex	13 2	*Ilex*	2 0		
		Others	1 9				

A pubescens Oliv

8		9	
Fagus	51 1	*Fagus*	26 8
Taraxacum	21 1	*Acer*	53 6
Heracleum	14 3	*Taraxacum*	17 4
Prunus	11 7	*Salix*	1 6
Others	1 8	Others	0 6

A bimaculata (Kirby) (2nd brood)

10		11		12		13	
Castanea	99	*Castanea*	61 4	*Castanea*	78 1	*Castanea*	36 2
Spiræa	1	*Spiræa*	34 4	*Rubus*	21 9	*Spiræa*	63 8
		Rubus	4 2				

In addition, pollen loads containing high proportions of *Quercus* pollen have been taken off *A. jacobi* Perk., and of *Castanea* pollen off *A. dorsata* (Kirby) and *A. thoracica* (Fab.).

The factors governing the choice of flowers visited by bees are probably numerous ; even the extensive investigations on the hive bee (*Apis mellifera* L.) have led to few definite conclusions[1]. Consideration of the results tabulated above raises several interesting queries.

In the first place, dealing with examples (7) and (10) : how do the bees manage to carry a practically pure load of poorly cohering *Quercus* or *Castanea* pollen diluted with only a small proportion of more 'sticky' pollen from nectariferous flowers ? In the hive bee, where separate journeys for nectar or pollen are normal, the pollen-carriers moisten the pollen with nectar to assist carriage, thus involving an appreciable number of visits to nectariferous blooms. It is difficult to imagine this being done without taking pollen from these flowers as well.

Secondly, what factors are responsible for diverting the bees from their normal pollen sources for tall trees with inconspicuous nectarless flowers, which, in the case of *Fagus* and *Quercus*, are very much obscured by foliage ? The remaining pollen species in the loads analysed are derived from low herbs or shrubs which have conspicuous flowers or are rich sources of nectar or both, and all were in sufficient abundance in the neighbourhood of the colonies from which the bees were taken upon their return. The taking of anemophilous pollen is not normal in *A. hæmorrhoa*, *A. armata* and *A. pubescens*, as only 4, 5 and 3 loads containing appreciable quantities have been found among totals of 42, 33 and 36 loads analysed respectively The catkins of *Castanea* are much more conspicuous than those of *Fagus* and *Quercus*, which may partly explain the frequent occurrence of this pollen species as a major constituent of loads of *A bimaculata* taken in localities where this tree abounds. It should be noted, however, that *Castanea* has previously been classified as entomophilous[2].

A possible explanation for the taking of *Fagus* and *Quercus* pollen by *Andrena* may be as follows. When the tree is in full flower and immense quantities of pollen are being liberated, it is reasonable to suppose that an atmospheric pollen concentration gradient will be set up around the tree, with a direction and rate of decrease in concentration depending upon the wind. A bee flying into this 'pollen field' will make a chemotropic response to the floating grains, and will orientate itself in the general direction of increasing pollen concentration and travel up the gradient until it arrives at the pollen source. Where the concentration of atmospheric pollen is low or uniform, the bee will make no directional response.

Although this suggestion can only be regarded as speculation until evidence based upon carefully chosen series of observations is available, the following experience may have some bearing upon it. A colony of *A. barbilabris* (Kirby) situated in a large plantation of Scots pine (*Pinus sylvestris*), in flower during the flight period of this species, was studied in 1943 and 1944. In the 83 pollen loads examined, *Pinus* was found only in negligible traces, the bees collecting pollen from nectariferous plants several hundred yards distant from the colony. Setting aside the possibility that *Pinus* pollen may be distasteful, upon the hypothesis put forward, the presence of a high but *uniform* atmospheric concentration of this pollen from the dense mass of trees had no orientating effect upon the bees' flight.

I hope to publish in due course detailed analyses of pollen loads of *Andrena*.

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[1] Weiss, H. B , *J. Econ. Ent* , **36**, 1 (1943), a review.
[2] Hyde, H. A , and Williams, D A , *New Phyt.*, **43**, 49 (1944)

Transmission of Kala-Azar to the Pouch Young of the Common Australian Possum (*Trichosurus vulpecula*)

KALA-AZAR is difficult to transmit to laboratory animals, with the exception of the hamster (*Cricetulus griseus*). This rodent, however, is not available in many countries.

Recently, through the courtesy of Dr. G. A. H. Heydon, School of Tropical Medicine, Sydney, a culture of kala-azar on N.N.N. medium was obtained, which was injected intraperitoneally into a pouch young of *Trichosurus vulpecula* about 2½ months old. The young, which at the time was practically hairless and still firmly attached to the nipple, was lifted out of the pouch of the anæsthetized mother, injected with 1 ml. of the broth washings of the culture tube and replaced into the pouch. One month after the injection, the young, still only covered by hairs

about 1–2 mm. long, was found to be leaving the pouch at periods

Seven weeks after the injection, the young was found to weigh 180 gm. which, compared with other young of approximately the same age, was at least 30 per cent below normal. Also the abdomen was somewhat distended, and the fur was short and sparse and remained like this until the experiment was terminated. Ten weeks after the injection of the culture of kala-azar, the animal was markedly undersized, frail and weak, though still eating and moving about freely. Its abdomen was markedly distended, and on palpation an enlarged liver and spleen could be felt. The possum now weighed 390 gm. It was anæsthetized with ether, and blood was obtained by heart puncture. A few minutes after this the animal died suddenly. An immediate autopsy showed a greatly enlarged spleen which had a mottled appearance, and on cross-section large whitish nodules were seen. It weighed 8·9 gm. This is at least five times the normal weight for an animal of this size The liver, which was greatly enlarged, was pale but contained numerous small diffuse, hæmorrhagic areas. It weighed 26·2 gm. The left and right kidney weighed 3·4 gm. and 3·2 gm. respectively. A blood count showed a marked microcytic anæmia with a colour index of 0·69. There were 22 nucleated red cells per 100 leucocytes and a marked neutropenia (4 per cent). A smear made from the pulp of the spleen contained numerous Leishman-Donovan bodies particularly in the cytoplasm of the monocytes. The parasites were also seen in sections of liver and bone marrow. In cultures prepared from spleen, sternum and blood, the flagellate form of the pathogenic protozoon could be seen.

The mother was killed some three weeks after the death of its offspring, and no evidence of infection could be found at autopsy in the spleen, liver, bone marrow or blood.

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A Wasp Preying on House-Flies and Stable-Flies

Rubrica surinamensis (DeGeer) is a large and striking neotropical wasp belonging to the family Bembicidæ. Its geographical range extends from the Argentine to Trinidad. It is commonly found nesting gregariously in a semi-social manner with other individuals in areas of bare sandy ground exposed to the sun. Flies of many different families comprise the prey. The flies captured are stung to death and used for provisioning the nest, the developing wasp larva being fed progressively from day to day.

In Trinidad this wasp normally preys upon horse-flies and hover-flies. However, other species of flies, including the house-fly, *Musca domestica* L., and the stable-fly, *Stomoxys calcitrans* (L.), have been observed on occasion to comprise the prey.

The wasp apparently exploits any readily available source of prey. Nests examined were sometimes found to contain the remains of many different kinds of flies. At other times only a single species was represented in the prey.

Wasps carrying house-flies were caught at the entrance to their nests. On digging up one such nest, a partly-grown wasp larva was found together with three intact house-flies and the remains of three others. Other individuals bearing stable-flies were similarly captured. In this case the abdomen of the prey was frequently greatly distended with blood. On releasing such wasps, they returned after a few minutes with other stable-flies, also gorged with blood. This was repeated a number of times. Apparently these individuals were utilizing a supply of stable-flies feeding presumably on livestock. The nest of one such wasp on examination was found to have been provisioned entirely with stable-flies.

As few natural enemies of either the house-fly or the stable-fly are known, it is thought to be of sufficient general interest to place the above observations on record.

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A Colonial Scientific Service

In the concluding remarks to his article[1] on *Anopheles gambiæ* in America, my old friend and colleague, Dr. John Smart, of the British Museum (Natural History), suggests that men engaged at present on anti-malarial or other entomological work with the Forces may be engaged after the War to continue work of this kind in the Colonies and elsewhere.

I have served in the Colonial Empire both as a scientific worker and as an administrative officer, and I believe the time will be ripe after the War for inaugurating a 'Colonial Scientific Service' or possibly even more than one scientific service, including perhaps a Colonial Biological Service. At any rate, such a scientific service would have its own departmental head (or heads), who would be responsible for the seconding of personnel to wherever they were wanted and to appropriate work. The departmental head would also be able to put together teams of scientific workers for attacking several problems from the necessary different points of approach in co-operation.

It may be said that those men of science who work in the already existing Colonial departments and the few scientific specialist departments (such, for example, as the Tsetse Research Department in Tanganyika) have already accomplished work of such value that no change is needed to improve quality or quantity of individual work by scientific workers in the Colonies. I should not disagree with such a view, but I think that the proposition of a Colonial Scientific Service or Services bears careful consideration from two points of view.

First, there is unnecessary divergence and consequent loss of efficiency due to the same problem being attacked in different Colonial territories by differently qualified personnel approaching it from different preconceived ideas of attack, as it were. To make this clear, let me again quote the very fine work done by the Tsetse Research Department in Tanganyika during some years; in the neighbouring Colony of Kenya, tsetse work is done entirely by the Veterinary Department, and the officer whose time is devoted entirely to this work at present is not an entomologist, but a veterinarian. In Nigeria, again, tsetse work is carried out by the Medical

Department. In Uganda, also, tsetse work was until comparatively recently carried out by the Medical Department. It is inevitable that to some extent such a variation in departmental authority over the same type of work in different territories must result in lack of co-operation and of a common policy, and in overlapping and duplication of work.

Secondly, there is the more human aspect of the position of the pure scientist in 'professional' or non-scientific Government departments. As I pointed out in an article published in South Africa this year: "Except for some medical entomologists, the rule is that the scientist is treated as inferior in every material respect (salary, pensions, quarters, ship accommodation, etc.) to 'professional' men. Clearly it is undesirable that scientists cannot work with 'professionals' as equals in scientific spheres, as it leads to resentment and lack of co-operation."

There are some scientific workers, whose experience has generally been largely academic, who would say that such observations show a mean spirit and a pre-occupation with money and material things. I have the greatest respect for this view and for some of its holders, who are in some cases older and have greater experience than I; and it is, in fact, an idealistic view with which I am temperamentally entirely in sympathy. But I think it is hard, if not impossible, for those who have not worked in India or the Colonies to realize just how much these small financial and social distinctions may mean in the lives of isolated communities of Europeans where the coloured folk and a great many 'whites' adjust their reaction to a nicety to each person, depending on his position in the 'staff list', his income, and outward signs of material prosperity and social status. In Tanganyika, a Government officer is allowed twenty-five porters per day on 'foot safari'; only the rawest greenhorn would ever take less, even if half of them were carrying nothing—for chiefs and others immediately class a man with only a few porters as a 'stiff' or 'poor white', and his way is made harder in getting food, water, directions and a hundred and one small but important ways which loom very big indeed in the 'Blue'. I know that we colonial Europeans probably go too far in our social attitude to position because of this environment in which we have lived (and often struggled) with so much awareness of how every minute of the day we were being socially 'weighed up' and our paths made appropriately smoother or rougher; but I think also the stay-at-home and the European who knows the 'Blue' only from expeditions errs a little at the other extreme of attaching no importance to these apparently trivial and worldly matters. The fact that a field zoologist, for example, has to travel second-class by train in Kenya (unless he pays part of his own fare) while a veterinary officer goes 'first' makes an incredible amount of difference to the attitude of native inhabitants to each; particularly as some non-Europeans always travel 'second' but seldom 'first'. I am not condoning this common native attitude—merely stating it.

It is only natural also that the 'specialist' should be more often than not passed over in Government departments when senior posts fall vacant. There are exceptions, such as that of the head of the Sudan Agricultural Department, who is an entomologist; but many cases on the other side could be quoted. I will give two only. The senior medical officer of a province in Tanganyika is in charge of a lunatic asylum for the whole territory. He has not specialized in mental cases, but was a pathologist in Nyasaland. This was his first chance of promotion—and promotion implied getting out of the blind alley of specialization. The chief veterinary entomologist in Kenya has worked in that Colony for more than fifteen years, but is paid less than a veterinary officer of comparatively junior standing.

If it is possible to have a Colonial Scientific Service (or Services) with its own head (or heads) who will second scientific men to where they are needed, this difficulty of the specialist being in effect often barred from high promotion would be removed, for every member of the scientific department or departments would then have an equal chance of promotion to the highest grades within his own department or departments. The outstanding example of such a method which has achieved such conspicuous success is, of course, the Tanganyika Tsetse Research Department. The success of the late Mr. Swynnerton in building up a colonial scientific specialist department may induce serious consideration of whether it is not a very worthy example to be followed.

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Sir Charles Boys

SINCE it was my good fortune to know Sir Charles Boys intimately during the last fifteen years or so, perhaps I may be permitted to add a word or two to the obituary by Prof. C. T. R. Wilson in *Nature* of January 13 about his great originality in everyday life. He was certainly original and unconventional in openly attributing any portion of his great success to his former *schoolmaster*, and I would further add that many was the time that Boys spoke to me of G. F. Rodwell, the first science master at Marlborough College, and his methods.

Boys also endeavoured to contribute to the science teaching at Marlborough, for not only did I return many times from visiting his home at St. Marybourne with my car weighed down with literature and apparatus, but also some ten years ago Boys had the two gold medals presented to him by the Royal Society photographed and then melted down. The photographs were framed and hung in the laboratories, and the money from the gold was given to establish a prize for experimental work in science.

At school Boys was certainly unconventional, for he confided to me that he took the College book of rules and broke every one of them in order. "I never stole or did anything criminal, but short of that there was not a rule I left unbroken," is what Boys told me on more than one occasion. Boys completely stripped the College clock and replaced the parts so effectively that the clock suddenly took on a new lease of life; the secret was not divulged until many years later. This job took Boys several weeks. Here we get some slight insight to the wonderful patience of Boys as a boy—that patience which enabled him to wait twenty-eight years for his first successful photograph of a progressive lightning flash.

Truly *Boys* was always *Boys*.

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TISSUE INDUCTION

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IN a regeneration there always originates from a causal point of view the question: Is the new tissue developed merely from pre-existing cells, which grow out from the original cell-units, or may also some other material be imagined as participating in the occurrence of regeneration? In the latter case, it is necessary to explain how an initially unspecific tissue is able to develop in a specific direction.

For several years I have been studying the healing of bones, especially from a causal-genetic point of view. At present, there are two doctrines which in different ways try to explain the regrowth of the bone tissue, namely, the specific osteoblastic theory and the metaplastic theory. According to the former, there are within the soft parts surrounding the skeleton—the periosteum, the marrow and the content of the bone canals—young bone cells which in the case of fracture grow out into the surroundings and there develop into completed bone tissue. In evidence of the correctness of this opinion are quoted first and foremost tests which show that isolated bits of the different skeletal layers after transplantation into non-osseous surroundings give rise to the formation of new bone. However, no careful or thorough morphological analysis of the reactions of the tissue has been made. It has simply been taken for granted that when bone formation is obtained, this must have emanated from transferred bone cells. This mechanism, however, seemed to me less probable. In the transplantation of a tissue, we must also expect that the cells of the graft in the new surroundings will not have the same favourable possibilities of growth, but will encounter a certain resistance in all those cell reactions and exudations which occur at the place of transplantation, and which tend to remove all those elements which are foreign in the physiological sense.

I have therefore carried out several transplantation tests with the different skeletal layers—periosteum[1], hard tissue[2] and bone-marrow[3]—into soft parts. In contradistinction to previous investigators, who as a rule have made observation over a long period in such tests, I considered it to be of importance at a very early stage—one or two days after implantation—to follow the reactions which take place both in the graft itself and in its surroundings. The result of such experiments went to show that the implanted skeletal parts died after a brief period. In the surroundings of the graft, on the other hand, it was observed that fresh bone grew from the mesenchymatous tissue. These investigations thus gave support to the so-called metaplastic theory, according to which connective tissue can be converted into bone tissue. From a causal point of view, however, the metaplastic theory is incomplete, since no one has been able to explain why the connective tissue under certain conditions passes in a perfectly regular way into bone tissue.

On the basis of the experience from these transplantation tests into soft parts, it was clear that there must be a certain connexion between the graft and the newly developed bone tissue. The morphological analysis of the tissue showed clearly that it is impossible to explain the connexion by direct growing-over of cells from the graft; for the fresh bone grows out of the newly developed mesenchymatous tissue in the surroundings. I then thought it possible that the specific factor necessary for differentiation of an unspecific surrounding might be transferred from the graft to the surroundings as some substance. This substance should be capable of extraction from the bone tissues. In order to examine this hypothesis, I prepared an extract of bone tissue with alcohol and injected it by a special method into the muscles. In 24 per cent of cases growths of cartilage and bone were obtained[4] (Fig. 1). Control tests with alcoholic extract of other tissues only were negative. These tests with the injection of an alcoholic, non-cellular bone extract have since been confirmed by Annersten[5] and by Bertelsen[6], who obtained cartilage or bone development in 20–50 per cent of their tests. The tests with bone extract free from cells thus go to show that a tissue within the fully developed organism is able to influence another in special differentiating direction by means of an extractable substance.

It became, then, of interest to see how far this tissue reaction had any general validity. Transmission tests with striated muscles showed the same results as similar tests with bone tissue[7]. On injecting

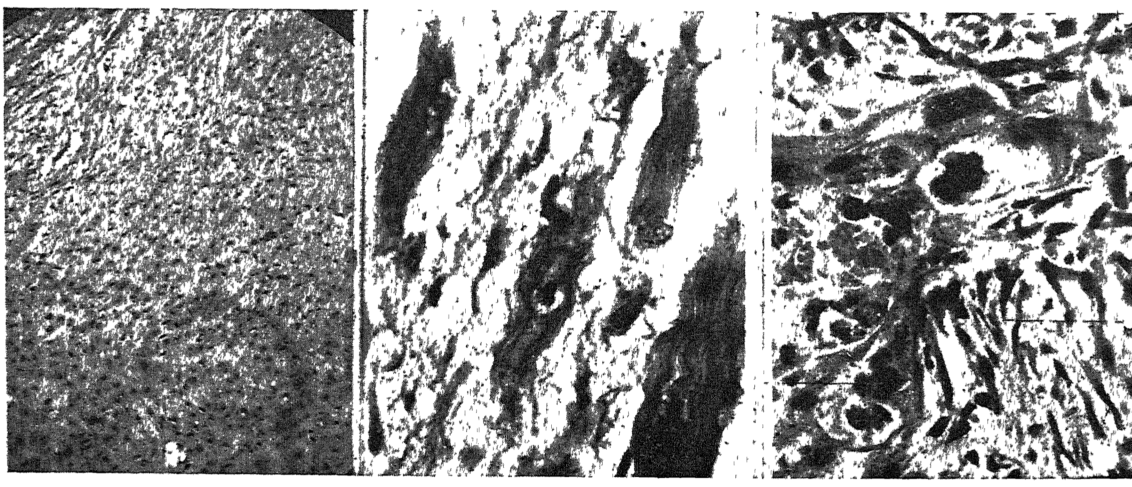

Fig. 1. CARTILAGE IN FORMATION AFTER INJECTION OF BONE EXTRACT.

Fig. 2. YOUNG MUSCLE FIBRES GROWING FROM A MESENCHYMAL TISSUE

Fig. 3 ENDOMETRIUM CELLS GROWING IN MESENCHYMAL TISSUE.

alcohol into the muscles, an abundant development of mesenchymatous tissue is obtained around the muscle fibres more or less degenerated by the action of the alcohol. At the same time, one gets a plentiful regeneration of muscular tissue. On a closer examination of these pictures, it is seen without difficulty that the newly developed muscles not infrequently grow in such a way that they cannot be imagined as having grown from old, pre-existing muscle fibres; but like the transplantation tests, must have developed directly from a mesenchymatous source (Fig. 2). I have furthermore tested the uterine mucous membrane (endometrium)[8]. It is well known in medicine how the uterine mucous membrane is found also outside the uterus, preferably around ovaries and oviducts, but also anywhere within the abdomen—so-called endometriosis. Endometriosis has also been encountered in the muscles of the extremities. These findings are, of course, in favour of endometriosis being caused rather by a substance which activates mesenchymatous tissue than by dissemination of disrupted cell units. Transplantation tests with the endometrium, like those with bone and muscle, also support this conception (Fig. 3). In all these transplantation tests, I have never found any mitotic developments likely to explain the specific new developments.

The circumstance that a tissue is able to affect another in a specifically differentiating direction I have termed 'induction'—a term borrowed from embryology, introduced, as is well known, by Spemann and his school at the turn of the century. In embryology one speaks about an organizer or a system of action that induces, and a reacting system which is being induced. According to Spemann, induction takes place by way of chemical substances. The opinion is held that the induction ceases at the moment the development of the embryo ceases. The investigations referred to above show, however, that such is not the case. In the fully developed organism, too, a specific differentiation may take place inductively at all ages. The similarity between the embryonal reactions and, by way of example, the implantation tests during the post-fœtal existence is clear. The graft in the fully developed organism corresponds to the embryonal organizer or activator, and the newly developed mesenchymal tissue at the place of implantation, which can be influenced by the graft in a differentiating direction, to the embryonal reactionary system. The post-fœtal presence of the induction mechanism thus means from the point of view of principle that the fully developed tissue comprises at least two components—a specific and an unspecific factor. Extraction tests with bone tissue show that the specific factor can be released from the tissue and dissolved in certain extraction fluids. This supports the view that the specificity of the tissue is confined to certain chemical substances. If in tissue regeneration we find that the unspecific mesenchymal tissue is developed in different directions, we must assume that these chemical substances are able to activate the unspecific mesenchymblast into specific differentiation. Also in embryology there prevails, as is well known, the idea that the induction is transmitted by certain substances, and a vast amount of work has been devoted to attempts to isolate these substances. No definite results appear, however, to have been reached for the present. According to Needham and Waddington, these substances would seem to belong to the steroid group. Annersten has obtained active extracts with fat-dissolving extraction agents. Since it seems that the same mechanism is active within both the fœtus and the fully developed organism as regards the explanation of growth, we are able to get a more comprehensive view of the development of tissues. There is every reason to assume that the same chemical substances are active both during the embryonal differentiation and during post-fœtal growth. Regeneration of tissue is, in other words, a repetition of embryonal development.

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TUNGSHAN OCEANOGRAPHICAL SURVEY IN 1941

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A FIVE-YEAR plan for oceanographical survey along the coast of Fukien was laid down in 1941 by the Department of Oceanography, China Institute of Geography, Pei-Peh, Szechuan, in co-operation with the Weather Bureau of Fukien, Yungan, Fukien. The purpose of such a survey is to give a complete picture, with the help of scientific knowledge, of coastal waters off Fukien. This investigation is expected to be a great help in the development of agriculture and fisheries. It may also be of benefit to the Salt Administration.

According to the plan, work has to be done systematically from south to north, along the coast, and this was started from Tungshan Island from 1941 onwards. The Tungshan Survey was made from the middle of September to the end of December 1941 by the Department of Oceanography in co-operation with the Weather Bureau of Fukien.

Workers engaged in the last survey were: Dr. S. F. Tang (oceanography and fisheries), Dr. T. Y. Ma (geology), Mr. Y. Chen (geography), Mr. K. M. Lin (physics), and Messrs. T. M. Chen and T. T. Young (meteorology). The first three were from the China Institute of Geography, Mr. Lin from the Research Academy of Fukien, Yungan, and the last two from the Weather Bureau of Fukien.

During the survey, observations on temperature, colour, transparency and specific gravity of the sea-water at each station were taken continuously for a period of twelve hours. Tides and currents at each point were carefully measured. Readings were taken every five minutes for a period of more than a day for the tide, and every half an hour for half a day for the current. Specimens of corals, shells, sea animals and seaweeds were comprehensively collected and preserved, and meteorological data were simultaneously taken. This work has been continued by the observatory station which was then established in Tungshan city.

Tungshan Island is situated in lat. 23° 32′–45′ N. and long. 117° 20′–32′ E. and lies off the border

between Kwangtung and Fukien Provinces. Its length from north to south is twenty-two miles, and its width from east to west is eighteen miles, a channel separates the northern part of the island from the mainland and connects Tungshan Harbour on the east with Chaoan Bay on the west. Tungshan Harbour is a fishery port, and Chaoan Bay is of importance for its saltworks. Fishing and salt-making enrich the islanders much more than the rice fields do the farmers on the mainland, though the lack of fresh water deprives the islanders of farming. As the results of warfare at sea, off-shore fisheries have practically disappeared On the other hand, salt manufacture, because of the encouragement given by the Central Government and the increase of salterns and labourers, has been tremendously developed during the last five years.

It is to be noted that Tungshan is an important fishery centre in Fukien Province, and Tungshan Harbour is a very useful port along the south-west coast of China. Both as biologists and fishery investigators, we want to know the natural conditions of the fauna and flora in Tungshan waters, since these will give precise knowledge as to the position of the intermediate zone, biologically speaking, between the tropical and the temperate seas. From the practical point of view, such general biological knowledge will lead us to more accurate conclusions as to fish migrations.

Tungshan Harbour is mid-way along the Amoy-Swatow sea route, and affords merchantmen and fishing vessels a very convenient shelter during the typhoon season. However, the nature of the tides and currents in Tungshan Harbour is not yet known, as the necessary observations have not been made.

Several papers have been published upon the last survey, both at Chungking and at Yungan, by the China Institute of Geography. I have prepared two papers: "The Tides and Currents around Tungshan Island" and "The Semi-daily Variations of Salinity in Tungshan Waters".

In the first of these, I have shown that the tides and currents around Tungshan Island are of the semi-diurnal type, and that the salinities of Tungshan waters are variable.

The second paper can be summarized as follows:

1. The salt-content of the waters around Tungshan Island, especially along the northern part, varies considerably in a day. The greatest range, from 23·20 to 31·40‰, was recorded in the water of Tungshan Channel, and the periodicity of the variation was found to be semi-diurnal.

2. It appears that around Tungshan Island the variation of salinity follows exactly the movement of the tide; that is, when the tide rises and the current is inward, the salinity of the water increases; when the tide recedes and the current is outward, the salinity of the water decreases.

3. The salinity of Tungshan waters was found to reach the highest point generally half an hour before high water, as the salt-water at the time of high tide has already been covered on the surface by a layer of brackish water which comes down from up-stream.

4. Considering the Tungshan waters as a whole, the highest salinity recorded was 33·03‰, the average was 28·12‰, and the lowest was 21·92‰. The difference of 5‰ between the highest and the average means that the water of high salinity may produce one-fifth more salt than that of the average salinity which is generally used by the salt-makers of Tungshan Island.

5. The best sea-water for filling up the reservoirs of the salterns around Tungshan Island can therefore only be obtained during the period from three hours to half an hour before high water; and the best day for filling up is the day following the new and full moons in each month.

ROLE OF ISOLATION IN THE DIFFERENTIATION OF PLANT SPECIES

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THE differentiation or origin of species depends upon the development of discontinuities or gaps in the variation pattern of Nature. We recognize species not because of the amount of difference between their most divergent individuals, but because of their distinctness from each other, or the breadth of the gap between them. The formation of these gaps between species depends upon the development of some isolating mechanism. Many different kinds of isolating mechanisms are found in Nature In order to understand the forces which direct evolution, we must solve two major problems. These are first, how isolating mechanisms develop and become established as barriers between species, and second, what relation they have to morphological divergence, or the "descent with modification" of Darwin.

As an aid to the solution of these two problems, evidence is produced from our knowledge of species and species hybrids in the higher plants to support the following five statements.

First, isolation of two groups of individuals by geographic barriers, even for very long periods of time, does not necessarily cause them to evolve into distinct species. Certain species of eastern North America have been isolated from their relatives in eastern Asia for millions of years, and yet the populations on the two continents have remained exactly like each other during these long ages. Second, if two species have become recognizably different as a result of long-continued geographic isolation, they do not necessarily become isolated by genetic barriers also. Some American species, such as the American sycamore (*Platanus*) (British plane) and the *Catalpa*, are different in appearance from their Asiatic relatives; but the hybrids between them have been found (by other workers) to be fully fertile. Third, genetic isolating mechanisms, such as cross-incompatibility and hybrid sterility, do not appear suddenly, but evolve slowly as do the visible differences between species. Many plant species, as typified in the genus *Pæonia*, are in hybridization experiments partly incompatible with each other or form partially sterile hybrids Such species may be in the process of evolving barriers of interspecific sterility between each other. Fourth, genetic isolating mechanisms have been produced artificially and analysed in laboratory or field experiments, but most of these mechanisms produce their effect in one or two large steps, and are transmitted in a relatively simple Mendelian fashion. On the other hand, the isolating barriers between natural species arise through the accumulation of many small steps, and are transmitted in the progeny of partially sterile interspecific hybrids according to the multiple factor pattern of inheritance. Fifth,

evidence from the progeny of partially sterile inter- and intra-specific hybrids in *Apocynum*, *Galeopsis*, and *Oryza* indicates that there is no direct genetic connexion between the causal agents of hybrid sterility and the genes which produce the visible differences between species This association in Nature is a result of parallel evolution.

Based upon these five assumptions, a working hypothesis is formulated to explain the relationship in evolution between morphological divergence, or descent with modification, and the development of discontinuities in the variation pattern of natural groups of organisms, or the origin of species. Descent with modification takes place as a result of the interaction between mutation, natural selection, and the random fixation of genes in small populations. If these forces are relatively static, the species will not evolve. Discontinuities are developed when two parts of a more or less rapidly evolving species are separated from each other by any of a number of isolating mechanisms. These mechanisms evolve gradually, and are genetically independent of the changes in outward form which produce visibly different species.

TERMITE-PROOFING OF TIMBER

TERMITES, or 'white ants' in popular terminology, are known to most of the inhabitants of the tropical parts of the world, and also to some warm temperate regions such as parts of the United States. Although occasionally introduced into Great Britain, they have never made any headway in this temperate island climate. Various remedies or preventions against the termites' attacks have been introduced or are practised locally in tropical countries—some effective, or partially effective, others more or less worthless. One of the greatest troubles and losses from this pest is the depredations it commits on furniture, instrument boxes, packing cases, etc., made in Britain (or in temperate Europe generally) and sent to the tropics; in termite-infested areas such have little chance of escaping destruction.

There is an exception—teak is unattacked, and so articles made from teak are immune. The writer had a full-plate expensive camera in India packed in a beautifully built teak wood box. It was left on the cement floor in a corner of a room in a well-built rest house out in the District. Returning three weeks later an inspection of the box showed traces of termites round the bottom edges. The box was unlocked and lid opened. The wood work of the camera, mahogany, was entirely eaten, skeleton 'beams' and cross pieces being left to support the brass mountings of the camera. At a touch the whole structure collapsed. An examination showed that the bottom of this expensive teak brass-cornered box had consisted of a piece of pine wood.

Leaflet No. 38 (Forest Prod. Res. Lab., Princes Risborough, Department of Scientific and Industrial Research; Aug. 1944) is entitled "Termite-Proofing of Timber for Use in the Tropics". This leaflet opens with the statement that manufacturers in Great Britain handling timber, or making furniture, etc., for use in the tropics are often called upon to render wood proof against possible infestation by the termites, and therefore are directly concerned in the injury which these insects may cause. It is admitted that in some countries termites cause the most serious damage, especially to permanent structures, unless precautions have been taken during their planning and construction. "In temporary structures and contents of buildings the risk of severe damage, it is said, is less and it need not be assumed that all materials or articles in which wood is present will at once be attacked and rapidly destroyed by termites when brought into a country in which these insects occur". There may be an element of truth in this, but the experience of many must render them chary of subscribing to this statement, or of taking the risk. Temporary structures may be ruined in a few days if left uninspected.

The leaflet summarizes information from a number of publications from certain countries, particularly from those of the Forest Research Institute, Dehra Dun, and the Bureau of Entomology, United States Department of Agriculture, and gives a brief account of how termite damage takes place; and also how it may be prevented. The subject is treated under the headings: habits of termites, prevention of damage, use of timber treated with wood preservatives, use of termite-resistant woods (among those usually available in Great Britain are iroko (*Chlorophera excelsa*), opepe (*Sarcocephalus diderrichii*), Pacific Coast redwood (*Sequoia sempervirens*), teak (*Tectona grandis*)). Plywood and fibre or composition boards and termite attack are also dealt with. It is said that treatment against termites will in most cases also prevent destruction of timber through fungal decay.

MAGNESIUM DEFICIENCY OF FRUIT TREES

THE occurrence of magnesium deficiency of fruit trees growing in the field has been recognized only in recent years. L Southwick (*Proc. Amer. Soc. Hort. Sci.*, 42, 85; 1943) describes a leaf blotch of apples which appears as an edge burn or interveinal necrosis, together with in some varieties a yellow banding or mottling of the leaves, appearing first in the older leaves and associated with a low magnesium content of the leaves, the scorched leaves usually containing less than 0·25 per cent magnesium. In the same journal D. Boynton, J. C. Cain and O. C. Compton report that seasonal variations in the potash and magnesium content of apple leaves agree with the seasonal differences in the incidence of leaf scorch and leaf blotch respectively. Leaf blotch due to magnesium deficiency may be reduced by soil application of magnesium sulphate, while it is aggravated by chloride of potash dressings (*ibid.*, 42, 95; 1943). L. Southwick and J. K. Shaw find that spraying with magnesium sulphate solution (16 lb. per 100 gallon) gave a partial control of the magnesium deficiency leaf blotch, and that most magnesium-containing substances applied to the soil were effective but magnesium limestone was ineffective in curing the trouble.

In the tung (*Aleurites fordii*) magnesium deficiency symptoms again consist of leaf blotches which increase in size at the margin and the development of brown necrotic areas which progress from the margin inwards between the main veins. As with apples, magnesium sulphate as a soil dressing effects a cure, but soil applications of potash aggravate the symptoms (M. Drosdoff and A. L. Kenworthy, *ibid.*, 44, 1; 1944).

FORTHCOMING EVENTS

Saturday, February 3

BIOCHEMICAL SOCIETY (at the British Post-Graduate Medical School, Ducane Road, Shepherds Bush, London, W 12), at 11 a m

Monday, February 5

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD GROUP with the LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 2 30 p m.—Dr F Bergel "The Use of Sugars and Amino Acids for the Preparation of Important Nutrients"

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S W.7), at 5 p.m.—Geographical Films.

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m—Mr Frank Parfett. Presidential Address

Tuesday, February 6

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m —Prof T Wallace "The Diagnosis of Mineral Deficiencies in Crop Plants", (2) "Methods of Diagnosis of Mineral Deficiencies"

INSTITUTION OF CIVIL ENGINEERS (STRUCTURAL AND BUILDING ENGINEERING DIVISION) (at Great George Street, Westminster, London S W.1), at 5 30 p m.—Mr J. L. Eve and Mr R C. Brown. "The Erection of Tall Guyed Masts"

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP with the OIL AND COLOUR CHEMISTS' ASSOCIATION) (at Manson House, 26 Portland Place, London, W 1), at 6 p m —Mr. J D Morgan "The Use of Cashew Nut Shell Liquid in Resins"

Wednesday, February 7

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3 p m —Inaugural Meeting of the Physical Methods Group, at 3.45 p m.—Mr R. C Chirnside · "Physics and the Analyst", at 4 30 p.m —Mr. H P. Rooksby · "Some Examples of the Use of the X-Ray Powder Diffraction Method in Quantitative Analysis; The Determination of Small Amounts of (a) Calcium Oxide in Magnesium Oxide, (b) Zinc Oxide in Zinc Sulphide".

PHYSICAL SOCIETY (COLOUR GROUP) (at the School of Photo-Engraving and Lithography, 6 Bolt Court, Fleet Street, London, E C 4), at 3 30 p m —Mr. H M Cartwright "Colour Printing and Problems of Colour Reproduction"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Flight-Lieut C B Bovill "Aerials for Use on Aircraft—A Comparison between Fixed and Trailing Types on the 900-Metre Wave-Band"

Thursday, February 8

LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at Burlington House, Piccadilly, London, W 1), at 2 15 p.m At 2.25 p.m —Dr. F W. Jane: "A Revision of the Genus *Harpochytrium*". at 3.5 p m —Prof C T. Ingold "The Tetra-radiate Spores of certain Aquatic Hyphomycetes and the Propagules in some Species of *Sphacelaria*", at 3 35 p m —Mr Ashley G. Lowndes · "The Swimming of *Monas* (Protozoa)".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p m —Prof. James Gray, F.R S : "Locomotory Mechanisms in Vertebrate Animals", (2) "Animal Flight".

CHEMICAL SOCIETY (joint meeting with the University College of North Wales Chemical Society) (in the Department of Chemistry, University College of North Wales, Bangor), at 5 30 p.m.—Prof M. Polanyi, F.R S. "The Strength of Carbon Bonds"

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W C.2), at 5.30 p.m —Mr. D. Rudd: "The Development of Motor Control Gear".

IRON AND STEEL INSTITUTE (joint meeting with the EBBW VALE METALLURGICAL SOCIETY) (in the Workman's Hall Ebbw Vale), at 6.30 p.m —Mr. G. D. Elliot. "Blast-Furnace Design, Operation and Problems".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m —Dr. S. A. Sarkisov (representative in Great Britain of the Red Cross and Red Crescent of the U.S S.R). "The Health Services of the Soviet Union".

Friday, February 9

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m —Mr. Walter H. Godfrey · "Architecture, a Study for Everyman".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p m.—Mr. C. C. Pounder "Diesel Propelling Engines—a Comparison of some Alternative Arrangements".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

GAS ENGINEER AND MANAGER of the Ilkeston Gas Undertaking—The Town Clerk, Town Hall, Ilkeston, Derbyshire (endorsed Gas Engineer and Manager') (February 8).

LECTURER IN AGRICULTURE at the Llysfasi Farm Institute—The Director of Education, Education Offices, Ruthin. Denbighshire (February 10).

TEACHER OF METAL WORK AND MACHINE DRAWING in the Junior Technical School of the Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster (February 10).

LECTURER FOR AERONAUTICAL OR MECHANICAL ENGINEERING SUBJECTS—The Secretary, Northampton Polytechnic, St John Street, London, E C 1 (February 12)

RIVER ENGINEER AND MANAGER (temporary) to the City of York—The Town Clerk, Guildhall, York (February 12)

LECTURER (full-time) IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Dagenham (February 12)

JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER by the Sierra Leone Government—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. E.903 A) (February 13)

MASTER to teach MATHEMATICS AND ENGINEERING DRAWING to Junior students—The Organizer of Further Education in Rugby. Rugby College of Technology and Arts, Rugby (February 16).

LECTURER IN THE CERAMICS DEPARTMENT—The Principal, North Staffordshire Technical College, Stoke-on-Trent (February 17)

ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, University College, Hull (March 1)

PHYSICIST OR PHYSICAL CHEMIST (man or woman) for research work on the rheology of dairy products, especially cheese—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (April 1)

UNIVERSITY LIBRARIAN—The President, University of Alberta, Edmonton, Alberta, Canada (April 1).

PROFESSOR OF MEDICINE—The Registrar, The University Manchester 13 (April 24)

UNIVERSITY READERSHIP IN ENTOMOLOGY, tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (July 31)

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield.

SENIOR LECTURER (male or female) in SOCIOLOGY in the Rhodes University College, Grahamstown, South Africa—The Ministry of Labour and National Service, Appointments Department A 3(A), Sardinia Street, Kingsway, London, W.C 2 (quoting Reference No O S 465)

ASSISTANT DAIRY BACTERIOLOGIST—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

TECHNICAL ASSISTANT, and a RESEARCH ASSISTANT, for biochemical work—The Administrator, Oxford Nutrition Survey, 10 Parks Road, Oxford.

LABORATORY APPRENTICE (girl) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N W 1

LABORATORY ASSISTANT FOR PHYSICS DEPARTMENT—Prof. H. Dingle, Imperial College of Science, South Kensington, London, S W 7

MANAGER OF THE RESEARCH FARM, Balerno, Midlothian—The Secretary, Institute of Animal Genetics, University of Edinburgh, West Mains Road, Edinburgh

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Aristotelian Society New Series, Vol. 44 Containing the Papers read before the Society during the Sixty-fifth Session 1943-1944. Pp xxx+160. (London Harrison and Sons, Ltd, 1944) 25s net [181

Medical Research Council Industrial Health Research Board Health Research in Industry (Proceedings of a Conference on Industrial Health Research held at the London School of Hygiene and Tropical Medicine, 28th September 1944.) Pp. 27 (London. H.M. Stationery Office, 1945) 6d net [191

Freshwater Biological Association of the British Empire Scientific Publication No 9 The British Simuliidae, with Keys to the Species in the Adult, Pupal and Larval Stages. By Dr. John Smart Pp 57 (Ambleside Freshwater Biological Association, 1944) 2s 6d [241

Institution of Civil Engineers Report on the Government White Paper on a National Water Policy Pp 16 (London Institution of Civil Engineers, 1944) [241

British Coal Utilisation Research Association. Programme of Work of Shell-type Boiler and Firing Equipment Committee (R 16) Pp. 8 (London · British Coal Utilisation Research Association, 1945) [241

Other Countries

Proceedings of the California Academy of Sciences, Fourth Series Vol 25, No 10. A Revision of some Arizona Cactaceae By Prof Lyman Benson Pp 245-268 (plate 25) Vol 25, No 11 Endemism in *Crepis* By Prof Ernest B. Babcock Pp. 269-290 Vol 25, No 12 *Nicotiana Arentsii*—A New, Naturally occurring, Amphidiploid Species. By T H. Goodspeed. Pp 291-306 (plates 26-27) Vol 25, No 13. The Cytogenetics of Hybrids in Bromus II, *Bromus carinatus* and *Bromus arizonicus* By G L Stebbins, Jr, H A. Togby and Jack R. Harlan. Pp 307-322 Vol 25, No. 14 The Importance of Field Hybrids in Determining the Species in the Genus *Ceanothus*. By Prof. Howard E. McMinn. Pp 323-356 (plates 28-36). (San Francisco · California Academy of Sciences, 1944) [101

Agricultural Experiment Station of the Rhode Island State College. Bulletin 291 Food Habits in Rhode Island. By Blanche M Kuschke Pp. 25 Bulletin 292: Newport City Milk Market. By J L. Tennant Pp. 35. Contribution 659 Wartime Agricultural Research (Fifty-sixth Annual Report) Pp. 46. (Kingston, R I. Rhode Island State College, 1944) [151

Catalogue

"Loud Hailer". Second edition. Pp. 24. (Guildford: Ardente Acoustic Laboratories, Ltd.)

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LOCAL MUSEUMS AND EDUCATION

SUGGESTIONS FOR FUTURE POLICY

IT is not yet generally recognized that local museums can, or should be able to, make a substantial contribution towards the education of the adult and juvenile population of their respective areas. Even the Ministry of Education, in its various 'recommendations', appears to have overlooked these veritable treasure houses of visual aids. What are the reasons for this ? Mr. S. F. Markham's Report, "The Museums and Art Galleries of the British Isles" (1938), probably supplies the answer, namely, that the majority of local museums, for some reason or another, are failing to carry out their functions adequately (see *Nature*, **143**, 447 ; 1939).

The Report clearly shows that the main causes for such a condition are : (1) the absence of sufficient expenditure, (2) the constitution of the governing body, and (3) "the great number of untrained and part-time curators". All these are closely related. Indeed, condition (2) is directly responsible for conditions (1) and (3), for where the governing body is composed of only half-interested, or frankly uninterested individuals (and this is not a rarity), there is not likely to be much expenditure either on museum improvements or on trained curatorial service. In the present pressing need of education in all its forms, this is an expensive economy.

Again, there are still too many local museums under the 'administration' of a library authority—an unsuitable situation in view of the unrelated work of library and museum. The 'library and museum' committee is not infrequently composed of individuals unacquainted with the work and aims of museums. The result is that the affairs of the museum tend to become subservient to those of the library. In this connexion it is not sufficiently realized that the qualifications of a museum committee member require more than a mere interest in 'old things'.

Such, then, are some of the conditions prevailing in many of the local museums of Britain. These form obstructions to improvement and progress, and, as such, it is high time they were removed. The removal of 'obstructions', however, often requires the impetus of public opinion ; and in Great Britain, unfortunately, there is very little public opinion in relation to the local museums.

The United States demonstrates to the whole world the very real value of the museum. In that country, museums were "deliberately created as part of the educational system" ("Libraries and Museums", by Sir Frederic Kenyon, 1930, Benn's Sixpenny Library, No. 100). Consequently, American museums have won and maintained strong public interest, and they are, therefore, liberally supported. In view of the attainment in the United States, it seems absurd that the museum-movement (as a whole) in Britain—where so much fine educational material is preserved—should remain 'sleeping' beneath the

impediments mentioned. There are museums scattered all over the British Isles—good, bad, and indifferent—but a great many of the local institutions, at the present time, have to be written off as 'bad' or 'indifferent'. Unless these are reorganized, they can serve no useful purpose in the post-war world. It becomes increasingly apparent, however, that some sort of Government intervention will be necessary before reorganization on the required scale will take place—a poor reflexion, perhaps, on local initiative.

Before passing on to other considerations, it may be appropriate here to mention two museums under the direction of the Education Department of the London County Council which prove their very real educational value. These are the Horniman Museum at Forest Hill, and the Geffrye Museum in Kingsland Road, E.2. The work of both these are well worth the attention of other educational authorities and every public-spirited person.

Those with but a hazy notion of museum values might here ask: What can (or should) a local museum offer towards the education of the people of its area? At least the following: visual instruction; facilities for study; popular lectures; æsthetic recreation, and a service especially designed for schools in the district. The latter should include the distribution of museum loans and arrangements for school talks. The permanent exhibits should be reinforced by a frequently changing series dealing with various subjects, and from time to time there should be special exhibitions to illustrate local talents (art, etc.) and local industries. Only when these amenities are widely offered will public interest be fostered and the local museum serve a useful purpose.

Since a service for schools is an important side-line —and one that promises to increase in scope—we would direct attention to some of the school loans schemes already in operation in Britain. The success of these, even where they are still limited, shows that the museums are strongly placed with regard to the visual aids of which nowadays we read and hear so much.

In this work the Victoria and Albert Museum in London has set the example. In 1937 (see Markham's Report) this Museum had a collection of loans comprising 41,015 works of art, 15,427 lantern slides, and 300 books, and these were issued to 413 secondary schools, 224 art schools, 94 local museums and 96 other institutions. This lead has been followed (naturally on a smaller scale) by the Leicester City Museum (the modern pioneer of such work), and the Derbyshire Education Committee. Both are extensive and county-wide in application, and their 'aids to education' afford a wide selection of portable exhibits dealing with most school subjects. In addition, school talks are arranged, and lately, Leicester has also organized a children's club within the Museum.

The Warwick Museum (Warwickshire Education Committee) launched a scheme—based on those of Derby and Leicester—in 1940. There, it is still in its early stages, and war-time conditions have made the building-up of the collection difficult. Nevertheless, this year several hundreds of items, including cases of museum specimens, models, sets of lantern slides and other illustrative material have been distributed on loan to many schools in the county.

There is an important condition in museum work in relation to schools, and that is the necessity of teachers having enough opportunity of making direct contact with the local museum curator, or schools' loans organizer. The teacher should be in the best position to know what, out of the museum's reserves, can be of most use for his or her purpose. Again, any available museum service should be widely advertised in the schools. Experience has indicated that far too few teachers are acquainted with the services which many museums can, or should, render.

It is clear that a considerable amount of educational work lies within the scope of the average local museum, if that institution be given a fair chance. All over the world to-day, the wholesale destruction of cultural material goes on. Some of our own treasures have suffered. Is it not time, therefore, that the mass of material still remaining to us be put to its fullest possible use? If, in the words of Sir Frederic Kenyon, "... museums have an important part to play in the formation of the citizen ...", it is vital that we do so.

PHYSICAL ADSORPTION

The Adsorption of Gases and Vapours
By Stephen Brunauer. Vol. 1: Physical Adsorption. Pp. vii+511. (London: Oxford University Press, 1944.) 35s. net.

DR. BRUNAUER has given in this, the first part of a work designed to cover all the phenomena of adsorption of gases on solids, by far the most thorough and comprehensive account that has yet appeared. It deals mainly with what is often called 'physical' adsorption, that is, adsorption in which the bulk of the adsorbate is held to the surface by van der Waals' forces, and the gas is below its critical temperature; but sufficient reference is made to 'chemisorption', where co-valent forces come into play, to put the whole subject of adsorption into proper perspective.

The relations between pressure, temperature, and the quantity adsorbed are treated with very great thoroughness; so is the heat of adsorption, and all the various theories which have been advanced to explain the shape of the isotherms. The account of the nature of the binding forces is also very full; indeed, the general account of the theories of the nature of van der Waals' attractive forces is as good as that in any text-book. Experimental methods are adequately treated, in all essentials, though rather less completely than is done for theories. The structure of the adsorbent, and also of the adsorbed film, receive as full attention as is possible in the present state of knowledge.

Perhaps the most important section of the book is that which expounds, in full detail, the 'multimole-

cular' adsorption theory of the author, Emmett and Teller. This theory takes account of the fraction of surface covered and the heat of adsorption, in each of a large number of layers on the surface; in the layers beyond the first, the heat of adsorption is taken as a first approximation, as equal to the heat of condensation to bulk liquid. Most of the numerous forms which the adsorption isotherms can take are explained, quantitatively, by this theory, with allowance for capillary condensation in the pores: it marks a very great advance on any preceding theories, and covers the great bulk of all possible cases of adsorption.

In the discussion of the structure of porous adsorbents, some of the theories quoted, notably those dealing with the apparent density of adsorbents such as charcoal, and the hysteresis sometimes found in adsorption, might perhaps be considerably clarified if more attention were paid to the contact angle between the substances adsorbed, when liquid, and the solid adsorbent. It would seem much more likely that the contact angle governs the extent of penetration of liquid into minute pores than the viscosity; indeed, I think that possibly this angle is a dominating factor in the values found for the apparent density, measured by the displacement of liquids. Perhaps also the well-known hysteresis of the contact angle, coming into play as an 'advancing' angle when capillary spaces are being filled with adsorbate, and a 'receding' angle, always smaller than the advancing angle, during desorption and emptying of capillaries, is largely responsible for adsorption hysteresis. The rather far-fetched theory which claims that pores in some adsorbents resemble 'ink-bottles' in shape might prove superfluous if attention were paid to this hysteresis of contact angles.

The treatment of the state of the adsorbed film is cautious; the author does not commit himself for, or against, recent theories which regard the adsorbed layer as possessing most of the properties of a two-dimensional gas even to the extent that the outward surface pressure of these gases can cause expansion of the adsorbent. Neither are the discontinuities in the adsorption isotherms, now based on experimental evidence from a number of sources, treated, except as a curious phenomenon not at present to be integrated with the rest of the theory. This caution would, however, seem well justified in the present state of knowledge.

The author is to be congratulated on a very fine account of a complex subject, more complex perhaps than most non-specialists will have suspected. He has given a very learned and well-balanced picture of practically all the important theories that have been proposed, and there are many of them. It is impartial—perhaps for some tastes a trifle too impartial, for the book has, in places, to be very carefully read to ascertain what the author's own views are; but the reader is always given very full material on which to base his own judgment.

The preface warns that we shall have to wait some time for the second volume, which is to deal with chemical adsorption. This is tantalizing, for one who can give such a stimulating account of what many people would expect to be the less interesting half of the subject should have something enthralling to say about the other half. He does, however, let fall one provocative remark, to whet our appetite for what is still to come, saying on p. 10, "there is some opposition even to-day to accepting the concept of activated adsorption". I myself, being still somewhat sceptical that slow adsorption can legitimately be ascribed to an energy of activation in the chemisorption of gases in the first layer, look forward impatiently to the author's promised marshalling of the evidence in its favour. It is a very important point of theory, and no one can be better fitted than the author for bringing all the evidence into proper focus; his knowledge is unsurpassed, and his fairness as an expositor seldom equalled. N. K. ADAM.

AVIATION MEDICINE

A Bibliography of Aviation Medicine and Supplement

By Phebe Margaret Hoff, Ebbe Curtis Hoff and John Farquhar Fulton. (Publication No. 9, Historical Library, Yale Medical Library.) Pp. xiv+109. (Washington, D.C.: National Research Council, 1944.) n.p.

AVIATION medicine has become a subject of prime practical importance in the present War. It is a subject in which the basic data from many fields of physiology are required in new applications. The compilation of a bibliography of aviation medicine is therefore a work of great value to those interested in this field. A large volume of work done in Service laboratories is not included, as this has not yet been published in open form; this is often less due to secrecy provisions than to the extreme preoccupation of the research workers with urgent operational problems. For, while many of the applications of physiology to aviation carried out in Service laboratories are at present restricted by secrecy considerations, the scientific basis of most of these rests on fundamental physiology often published many years before the War; this bibliography covers the field in all its ramifications. Only a few applied sections are seriously incomplete and must remain so until after the War.

This Bibliography, first published in 1942, is now followed by a supplement, mostly of work published since 1940.

The classification by subject-matter is convenient, and all references are given numbers used for reference in cross-indexing at the foot of each subsection. An author index is included.

The section "Special Physiology of Aviation and Conditions Simulating Flight" occupies nearly half the volume and is divided into twenty-three physiological divisions further subdivided.

The Bibliography is comprehensive and includes historical works and accounts of early balloon and mountain ascents where these contained any pertinent matter.

Research on the effects of altitude may be divided historically into two parts, from Robert Boyle to Paul Bert, and Paul Bert to the present. Robert Boyle subjected animals to low pressure and recorded seeing a bubble in the eye of a viper when exposed to low pressure, and so might be considered the discoverer of decompression sickness. Modern research dates from Bert, who laid the main foundations of modern knowledge in his great work "La Pression Barométrique", published in 1878.

The book is excellently produced, and the arrangement could well serve as a model of bibliography.

B. H. C. MATTHEWS.

PLANT VIRUSES AND VIRUS DISEASES*

By F. C. BAWDEN
Rothamsted Experimental Station

THE existence of viruses was first deduced from work done in 1892 on tobacco plants suffering from mosaic, and much of what we now know of these elusive entities has come from further work on this and a few other plant diseases. It is far from certain that this knowledge can safely be applied to the causes of the many diseases, affecting all kinds of animals, higher plants and bacteria, that are now attributed to viruses. These cover a wide range of clinical conditions, and we know for certain of only two features that they have in common; their causes have neither been seen nor cultivated *in vitro*. If we wish, we can turn these negative features into what looks like a positive statement, by defining viruses as obligately parasitic pathogens too small to be resolved by microscopes using visible light. Indefinite as this is, it may still prove to be more precise than the facts warrant, for obligate parasitism is always postulated rather than proved, and serious attempts at cultivation have actually been made with very few viruses. Thus, when we speak of a virus disease, we usually mean merely an infectious disease with an invisible cause. Unless the resolving power of the microscope has some unsuspected significance in defining biological types, this obviously tells us nothing specific about the nature of viruses and might well cover a range of different entities.

This possibility seems increasingly likely when we try to generalize about plant virus diseases, for we find that no statements can be made about such features as symptoms, methods of infection, or distribution of virus in the host, to which there are no exceptions. This is far from conclusive, however, for what a virus does to a plant is as much a property of the plant as of the virus, and the same virus may produce very different effects in different plants. Also, although complete generalizations are impossible, there are some features shared by a number of different virus diseases, especially those met commonly in Nature.

The effects most frequently caused by viruses are a dwarfing of the host plants and an alteration of the colour and shape of the leaves. Instead of being uniformly dark green, the leaves may bear spots, rings or patches of light green, yellow or white, or they may be generally chlorotic without definite mottling. Deformation may show only as an alteration in the leaf outline, or the laminæ may be so reduced that the leaves consist of little but the main veins; it may take the form of local hyperplasia, to give unusual outgrowths from the leaves or gall-like proliferations in stems. Symptoms tend to occur more generally over a whole plant than with most fungal or bacterial diseases, for in natural infections it is usual for viruses to spread through the vegetative parts of affected plants. In plants infected experimentally, however, symptoms are often restricted to local lesions, produced by the death of tissues around the entry point. Diagnosis from symptoms is by no means easy, for different viruses may cause almost identical symptoms in the same host, whereas the same virus may produce totally different clinical conditions in different hosts. A further complication is that many viruses are unstable and frequently change to give forms that produce different symptoms from those produced by the parent virus. To be recognized, a virus must cause changes in the appearance of some plants; but it need not necessarily cause changes in all susceptible hosts. Indeed, the phenomenon of the carrier—an infected individual showing no symptoms—is common in plants, and such carriers can be of considerable importance as unsuspected sources of infection for intolerant species

In many virus diseases, three distinct phases can be identified. As a result of virus multiplication at sites of infection, lesions first appear on inoculated leaves. After a few days, the virus passes to the phloem, through which it travels rapidly to distant parts of the plant. It seems to have no autonomous movement, but to travel along with the translocation stream of elaborated food materials, away from tissues actively engaged in photosynthesis and towards regions of active growth. It is because of this, and not because they resist infection, that leaves already fully developed at the time the plant becomes infected rarely show symptoms Thus results of systemic infection appear on the young, actively growing leaves; the later symptoms of this systemic phase often differ from those first produced, as the disease passes from an acute to a chronic stage. Often both stages are serious diseases; in many potato varieties, for example, leaf-drop-streak is succeeded by severe mosaic. Occasionally, however, the chronic stage is extremely mild, such as in tobacco plants with ring-spot, which recover from the acute necrotic disease and afterwards show few or no symptoms The virus is present in such plants, but in smaller quantities than during the acute stage. The sequence of three phases is common, but by no means general, and the same virus may give different sequences in different hosts. Potato virus Y, for example, gives local lesions only in one host, local lesions followed by systemic symptoms of two kinds in a second host, whereas in a third it gives no local lesions and systemic symptoms of only one kind.

In addition to altering the external appearance of plants, viruses also produce internal changes. Some of these are simply modifications of normal structures or tissues, such as reduction of the chloroplasts or necrosis of the phloem; but the most characteristic involve the production of new kinds of intracellular inclusion bodies. These are not found in all virus diseases, but their formation appears to be specific to viruses, for similar bodies have not been found either in healthy plants or in those suffering from other kinds of disease. Different viruses give rise to different kinds of inclusion body, and produce them in varying numbers and in different tissues. The most general type is a vacuolar, amœboid-like body found in the cytoplasm, but crystalline and fibrous inclusions also occur in infections with a number of different viruses. At least two viruses give rise to crystalline inclusions in the nuclei. The precise nature of these bodies is still uncertain; but we know that they contain virus, and their production can in part be simulated *in vitro*. It seems most likely that they are insoluble complexes produced by the viruses combining with some metabolic product of the diseased plants.

Symptomatology without proof of transmissibility is insufficient to assign a particular disease to the virus group, for similar kinds of symptoms can be caused by toxins, deficiencies of mineral nutrients

* Substance of two lectures at the Royal Institution delivered on November 21 and 28.

and aberrant genes. With hosts that are easily grafted, transmission by grafting is usually the first method tried; for once organic union is established, all viruses that cause systemic symptoms readily pass from infected scions into healthy stocks. Indeed, grafting is the only method of transmission known for many virus diseases, and it has almost become the critical test of a plant virus disease.

Infection occurs only through wounds, but wounds that permit one virus to enter may not permit another. Many viruses are readily transmitted by rubbing healthy leaves with sap from diseased plants, but others are not; some of both these types are transmitted by insects. Several different explanations can be offered for the failure of inoculation to transmit viruses that are readily transmitted by insects. First, some viruses may be able to establish themselves only in deep-seated tissues, such as the phloem, which are not penetrated by ordinary inoculation methods. Secondly, conditions in the expressed sap of some hosts may be such that the viruses are rapidly destroyed or rendered non-infective. Thirdly, the virus content of sap from some diseased plants may be below that required for infection. Thus, although failure to transmit by inoculation is often used as a specific character of a virus, clearly it may equally well be a reflexion of some property of the host.

Insects do not seem to act simply as mechanical carriers of viruses, for no insect vectors are known for the two viruses most easily transmitted by inoculation; and there appear to be specific relationships between insects and the viruses they transmit Individual viruses are usually transmitted by only a few related species of insect and not by others, though these may have similar feeding habits and be vectors of other viruses. Vectors are usually insects with sucking mouth-parts; the most important are aphides, leaf-hoppers, white-fly and thrips. Two main types of behaviour in the insect have been distinguished. Vectors of one type of virus can infect healthy plants immediately after feeding for a short time on a diseased plant, and these usually cease to be infective within a few hours. After feeding on diseased plants, vectors of the other type cannot infect healthy plants for some time, which varies from minutes to days with different viruses, and such vectors remain infective for long periods, often for their whole lives. Some workers believe that viruses of the second type multiply in the insects. There is no obvious reason why they should not, and the theory would explain some of the now puzzling features of the behaviour of these viruses; but there is no conclusive evidence that insects ever contain more virus than they acquire while feeding on infected plants. Studies on the virus causing dwarf disease of rice supplies the best circumstantial evidence for multiplication. This virus is unique in being the only one known to pass from infective adults through eggs to their progeny. Progeny up to the seventh generation have once been found to be infective and from one infected egg the progeny have infected more than 1,000 plants. This is regarded by some workers as 'overwhelming' evidence for multiplication, as they consider that the quantity of virus in the original eggs could not have been enough to give all the infections. But is this so? If the virus multiplied in the insects to anything like the extent it does in plants, then there would be no reason why the progeny should not continue to be infective indefinitely, and infect as many plants as they feed on. We know nothing of the size of this virus, but if it is of the same order as other plant viruses the sizes of which are approximately known, then 1,000 particles would weigh less than 10^{-14} gm., and many times this quantity could surely be contained in a leaf-hopper's egg without difficulty.

Transmission of some viruses has been achieved by linking diseased and healthy plants with the parasite dodder (*Cuscuta* sp.) This novel method of transmission promises to be valuable in extending the host ranges of some viruses to plants more favourable for study than those in which the viruses occur naturally One of the greatest differences between individual viruses lies in the numbers of different plants they can attack. Some are known to infect hundreds of plant species, belonging to many different families and orders; others have been transmitted to only a few closely related species. This difference may be apparent rather than real, for viruses transmissible only by grafting or by insects will normally have host ranges restricted to plants which can be intergrafted or which can act as food plants for the insect vector.

For more than forty years, work on plant viruses was largely concerned with symptoms, transmission and host ranges. It showed that viruses could multiply and alter, and produced few results conflicting with the generally accepted conclusion that they were small organisms, essentially similar to bacteria. There were opposers of this, usually from among those studying tobacco mosaic virus, but they could offer nothing definite to support their alternative views. The intensive study during the last ten years of the viruses *in vitro* has led to results that necessitate considerable modification of the earlier views. They do not, however, justify the sweeping conclusions implied by such facile phrases as 'lifeless molecules', which are increasingly applied to viruses.

What has been achieved is the successful application of the techniques of protein chemistry to the purification of a dozen or so viruses. This has shown us that the particles of these viruses are not organized cellularly like organisms, and that in many ways they resemble constituent parts of organisms rather than whole organisms They can be obtained in forms chemically much simpler than bacteria, free from diffusible components, and with a much greater regularity of internal structure than is usual with organisms. The viruses so far purified have all been obtained in the same chemical form, as nucleoproteins. They all contain nucleic acid of the ribose type, but the proportion of nucleic acid to protein varies with the individual viruses. It is far too early to conclude that all plant viruses are essentially nucleoproteins; but we can say that it will be a major discovery if one is found to be anything else, for those already purified cover a diversity of types, some known to be insect-transmitted and others not. They range from potato virus Y, which denatures and loses infectivity within a few days, to tobacco mosaic virus, which remains stable for years. Stability as a native protein, however, is not always the same thing as stability as a virus; the infectivity of preparations of any of these viruses can be destroyed by some treatments that have no appreciable effects on the physical, chemical and serological properties.

The shape of the particle is responsible for some of the most striking differences between the properties of preparations of different viruses. Solutions of purified tobacco mosaic virus, and of potato viruses X and Y, show phenomena characteristic of greatly

elongated particles; they are anomalous in all their physical properties and are polydisperse. No true crystals have been prepared from these, but dilute solutions show anisotropy of flow strongly, and concentrated solutions are liquid crystalline. X-ray studies of solutions of tobacco mosaic virus have demonstrated a regularity of structure previously unsuspected in fluids, for the particles are arranged equidistant from one another so that the available space is filled uniformly. When mixed with their antisera, these rod-shaped virus particles precipitate almost immediately, giving bulky, fluffy precipitates resembling those produced by bacterial flagellar antigens.

Solutions of bushy stunt and tobacco necrosis viruses behave very differently and show none of the anomalous properties characteristic of elongated particles. By suitable treatments they can be induced to crystallize in forms characteristic of the individual virus. When mixed with their antisera, they precipitate more slowly than the rod-shaped viruses and, as might be expected with spherical particles, pack more closely to give dense, granular precipitates resembling those produced by somatic antigens.

What is the relationship between these isolated nucleoproteins, which in laboratory work behave much like preparations of other proteins, and the viruses as they occur in the plant? There is enough evidence now to show that these proteins are the viruses in the sense that they can initiate infection. Nevertheless, it would be premature to assume that, while active in the host plant, the viruses are chemically so simple as analysis of the purified preparations suggests. During the course of isolation, many materials are discarded as impurities; most of these are certainly constituents of the normal host, but some may well be specific products of virus activity. Any such are clearly not essential for infectivity; but if the virus were organized cellularly, they would be retained within a cell wall and would be accepted as integral parts of the virus, which would immediately look a much more complex body than does our naked protein particle.

In the absence of specific tests for any product of virus activity, we have no positive evidence for their occurrence in plants, but evidence from various sources suggests that purification may be altering the viruses. Purified preparations of tobacco mosaic virus, for example, contain particles about 15 mμ wide but varying in length from less than 100 mμ to more than 1,000 mμ. There is nothing to show that the greatly elongated particles occur in the plant, and much to suggest that they are produced by the linear aggregation of small particles during the course of preparation. By taking suitable precautions, solutions of tobacco mosaic virus can be made that show little or no anisotropy of flow and behave serologically more like somatic antigens; but these are unstable and readily change into anisotropic solutions with serological behaviour characteristic of flagellar antigens. This change seems to be connected with the removal of other material from the small nucleoprotein particles, which then join together end-to-end. The change in size and shape may explain the failure to produce true crystals of this virus *in vitro*, though they occur abundantly in infected plants.

We know also that the purified virus readily combines with other proteins such as trypsin and ribonuclease, and that these can be removed again without affecting infectivity. May not similar combinations occur within the host, and be responsible for converting this nucleoprotein into a functioning system capable of multiplication and of the activities of which the results are so obvious?

In addition to the changes produced by purification, there is other evidence that virus does occur in the plant in forms with different properties from those of the purified nucleoproteins. Until recently, all laboratory work on plant viruses was done with the sap that is expressed from macerated infected leaves. This was thought to contain all the virus in the plant, for washing the fibrous residues gives little extra virus. However, these residues actually contain as much virus as does the sap, but normally this is insoluble, probably because it is combined with other substances, and special treatments are needed to get it into solution. It is possible that this insoluble virus is the biologically active system, whereas that free in the sap may be merely excess virus functioning as a mobile source of infection for other cells. We know so little about the multiplication of viruses, and of their activities within the host, that at present we must suspend judgment. But it is probably safest to regard the nucleoproteins as the chemical minima—equivalent to reproductive organs or embryonic viruses—which develop into working entities only when placed in an environment containing the materials or enzyme systems they lack in their purified state.

CHEMISTRY AT THE OLDER UNIVERSITIES OF BRITAIN DURING THE EIGHTEENTH CENTURY

By ARCHIBALD CLOW
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IN 1814 Sir John Sinclair, president of the Board of Agriculture, wrote:

"At present there are a greater number of intelligent practical chemists in Scotland, in proportion to the population, than perhaps in any other country in the world" (J. Sinclair, "General Report", App. 2, p. 307).

In the light of this rather startling assertion, it is instructive to analyse the development of chemistry in the universities of Scotland during the preceding hundred years, and to compare it with developments farther south. In Great Britain there are five universities to consider: in England, Oxford and Cambridge; in Scotland, Edinburgh, Glasgow and Aberdeen. There was no profession of chemistry at St. Andrews until at a later date.

While alchemy yet held the field, the universities of Scotland remained aloof from the flux of gold and elixir making, but at the end of the seventeenth century the Surgeons' Incorporation in Edinburgh established a laboratory where apprentice apothecaries received a chemical training. The instigator of this pioneer development was Alexander Monteith. He was thus a contemporary of Sir Isaac Newton (1642–1727), who in Cambridge was still studying Boyle's method of gold-making during 1690–93, perhaps not without hope of practical application, since within a few years he was appointed Warden of the Mint.

In the early years of the eighteenth century, the Town Council of Edinburgh decided to appoint a

professor of chemistry in the Town s College, and in 1713 James Crawford was selected to fill the chair. Crawford did not achieve European reputation, but he was a product of the great Boerhaave school at Leyden, and his appointment to Edinburgh is significant. It inseminated Scotland with the finest seed of Continental chemistry, and it gave professorial status to a teacher of chemistry in advance of most other countries. The only other university with a like claim is Oxford. On cursory examination it appears that, as a centre of chemical activity, Oxford has indeed a better claim. This arises in the main from its association with the alchemistic Roger Bacon, but even R. T. Gunther points out that "it is a moot point whether Roger Bacon really made much impression on his contemporaries; if any, it was evanescent; and in the succeeding centuries Oxford savants continued to wander in a maze of arbitrary figments and partial inductions, in which experimental science found no place". (R. T. Gunther, "Early Science in Oxford", 7.)

In the middle of the seventeenth century, we find that for a time Oxford did indeed give hospitality to an evacuee, Robert Boyle (1627–91), one of the greatest of contemporary thinkers. For fourteen years from 1654 Boyle was at Oxford. While there, he became the centre of a small coterie of intellectuals who doubtless helped to bring about what J. U. Nef calls the first English industrial revolution. Boyle's influence was rather that of a patron experimentalist than a teacher; but he was responsible for introducing to Oxford its first regular teacher of practical chemistry. It was a long time, however, before the teaching of chemistry became continuous. In compensation for the paucity of chemical instruction, an important contribution to technics made by an Oxford B.C.L. may be mentioned.

"The mystery of salt-glazed stone ware was discovered by the ingenious John Dwight of Christ Church, who set up a manufacture at Fulham. . . . When and where John Dwight became acquainted with this use of salt is not known but in 1671 he took out a patent for his process, and in the same year the first specimens of salt-glazed ware were being manufactured at Fulham. Soon after 1688 similar ware was being produced at Burslem by the Dutchman Elers, and in 1700 in Nottingham". (R. T. Gunther, "Early Science in Oxford", 27.)

Oxford suffered from its proximity to London, and the removal of Boyle (as well as of other intellectuals which followed the more settled conditions of state established in 1660) did irreparable damage to its scientific life. The only man of science worthy of the name who remained was John Mayow, whose "De sal-nitro et spiritu nitro-aereo" heralded the later discovery of oxygen. But Mayow too left Oxford in 1675, and died in 1678.

"Thus closed the brief life of the greatest chemist whom Oxford has ever produced. His works, a century in advance of the times, were unappreciated during his life and were soon neglected, buried and forgotten under a thick pall woven in Germany by Stahl, out of a warp of genuine facts and a weft of false hypotheses". (R. T. Gunther, "Early Science in Oxford, 32.)

By one of the unfortunate accidents to which collegiate monasticisms are prone, Mayow was not an associate of Boyle; indeed they seem to have been mutually unaware of each other's work, and Mayow's contributions remained hidden for many years. Yet his manipulative skill substantiates his claim to be considered one of the founders of pneumatic chemistry. Thus while Oxford may claim an earlier contribution of chemistry applied to manufactures than can Edinburgh, its periods of seventeenth century brilliance were sporadic and contrast markedly with the continuity of chemical teaching undertaken at Edinburgh.

So far as continuity is concerned, albeit it was mediocre, Cambridge fared better than Oxford. In the early years of the eighteenth century, that is, contemporary with Crawford's professorship at Edinburgh, the title of honorary professor of chemistry at Cambridge was conferred on one J. F. Vagani (*c.* 1650–1713), a native of Verona. Of Vagani we know little, but he was probably the first chemist there to throw off the alchemical tradition. From records of purchases made to illustrate his lectures, it is highly probable that they were biased towards pharmaceutical ends. It is interesting to note that one of Vagani's students was Stephen Hales (1677–1761), whose researches on the chemical reactions of plants laid the foundation on which Francis Home of Edinburgh was able to build his "Principles of Vegetation".

Vagani was followed by John Waller, who lectured until 1718, and Waller in turn by John Mickleburgh, who brings us up to 1741.

By this time great changes had taken place in Scotland. In 1724, four fellows of the Royal College of Physicians announced that they had purchased a house in Edinburgh for a chemical laboratory, and indicated that they proposed to lecture extra-murally on chemistry and *materia medica*. Every one of them had studied at Leyden under the celebrated Boerhaave, and thus went to Edinburgh with the finest training that could be obtained at the time. They were Drs. John Rutherford (1695–1779), Andrew Plummer (*d.* 1756), John Innes (*d.* 1733) and Andrew St. Clair. After extra-mural teaching for a few years, they insinuated themselves into the University, which for a time boasted four "professors of chemistry". None of the quartet made revolutionary contributions to the advance of chemical theory or practice—Rutherford's son discovered nitrogen, it is true—but their significance in the history of technology and science lies not in their own contribution but in the pioneer foundations established by their students. Plummer particularly was the mentor of several founders of chemical industry, as well as of two of the greatest academic chemists Scotland, or for that matter any country, has produced, namely, William Cullen (1710–90) and Joseph Black (1728–99).

Of Plummer's industrialist pupils, John Roebuck (1718–94) is the most important. The manufacture of sulphuric acid was first carried out in England on what may be called an industrial scale when Dr. John Roebuck, in company with Samuel Garbett (1717–1805), established his works at Steelhouse Lane, Birmingham, in 1746. They set up a second works at Prestonpans in 1749, and with the profits gained in these very successful enterprises Roebuck went on to found Carron Iron Works in 1760, thus opening up for the first time the carboniferous deposits of central Scotland.

The establishment of sulphuric acid manufacture on an industrial scale in both England and Scotland by Roebuck and Garbett—and it must be remembered that Roebuck's interest in chemistry was derived from Plummer's teaching at Edinburgh—is of signal importance, since it almost immediately brought

about a revolution in the art of bleaching by the application of the researches of another Edinburgh professor, Francis Home (1719–1813), professor of *materia medica* in the University from 1768. The introduction of sulphuric acid at this early stage in the industrialization of bleaching was indeed a milestone in the long chain of contributions made by Scottish chemists to industrial development.

About the same time as Roebuck settled at Prestonpans, another student of Plummer began to engage in chemical manufacture. He was no other than the celebrated Scottish geologist, James Hutton (1726–97). Beckmann in his "History of Inventions and Discoveries" states:

"If I am not mistaken, the first real manufactories of sal ammoniac were established in Scotland; and the oldest of these, perhaps, was that erected by Dovin and Hutton at Edinburgh in 1756* and which, like many in England, manufactures this salt on a large scale" (4, 383)

Soot was the raw material used, and they continued to use it for many years until they began to buy crude sal ammoniac from a tar works that had been established in the interim by Lord Dundonald at Culross.

All this has to be set against "the mystery of salt-glazed stone ware", contributed by Oxford.

From Edinburgh the teaching of chemistry spread to the University of Glasgow. William Cullen (1710–90), having studied arts at Glasgow and medicine under Plummer at Edinburgh, was appointed a teacher of medicine at Glasgow in 1746. Stimulated by Plummer's teaching, he developed a dominant interest in chemistry, and in 1747 induced the University to establish the teaching of *Chemie*. In the same year, Cullen himself, and a John Carrick, were appointed lecturers in chemistry. Carrick however died in 1750, and Cullen was left to continue the course on his own.

Cullen's outlook on chemistry was severely practical, as has been that of all great Scottish chemists. At the beginning of his second course he printed and distributed "The Plan of a Course of Chemical Lectures and Experiments directed chiefly to the Improvement of Arts and Manufactures". He clearly recognized the importance of scientific chemistry and its application to industrial and agricultural development. While in Glasgow he devoted a considerable part of his time to industrial problems of the time, particularly to those subjects of which industry demanded a chemical investigation, for example, salt-boiling, bleaching, and alkali supply.

"He was a great master of the scientific branches of husbandry; a consummate botanist, and possessed a correct taste in the fine arts. In the year 1758, after finishing off chemistry, he delivered to a number of particular friends, and favourite pupils, more lectures on the subject of agriculture. In these few lectures, he, for the first time, laid open the true principle concerning the nature of soils, and the operations of manures." (A. Bower, "History of the University of Edinburgh", 2, 392.)

In 1751, Cullen was appointed professor of medicine and lecturer in chemistry at Glasgow, which posts he held until 1755, when he was appointed colleague and successor to Plummer, and moved to Edinburgh. In Glasgow he was succeeded by Joseph Black (1728–99), who followed him both at Glasgow (1756) and later at Edinburgh (1766).

* The correct date is a good deal earlier than that given by Beckmann.

If we compare the number of students reading chemistry at Edinburgh and at Cambridge at this period, it is likely that Edinburgh will be found to have the smaller number, but an expansion took place almost immediately. In the light of these figures we can sympathize with Davies, who wrote to Stephen Hales in 1759 lamenting that at Cambridge,

"Anatomy, botany, chemistry, and pharmacy have been but occasionally taught; when some person of superior talents has stayed up and has honoured the University by his first display of them, before his passage into the world". (R. Davies to S. Hales, 1759.)

In Scotland at this date Cullen was teaching in Edinburgh and Black in Glasgow.

In 1766 Black went to Edinburgh to succeed Cullen, who had been translated to another chair, and for thirty years he occupied the chair of chemistry during one of the great formative periods through which chemistry has gone, both in expansion on the theoretical side and in its application to industry. So great were Black's contributions to fundamental chemistry that one is apt to forget that he also kept in close touch with contemporary industrial developments, especially in a consultative capacity, and through personal contact with friends like Roebuck and Hutton. Of particular interest are his attempts, in collaboration with Roebuck and James Watt, to synthesize alkali; his connexion with the initial stages of Lord Dundonald's Tar Works. Problems concerning Cort's process for the production of malleable iron were referred to him. He advised on potter problems. Specimens of ore and water from the lead mines at Wanlockhead and Leadhills were sent to him for analysis. His opinion was sought by the committee investigating Scottish distillery. He devised methods for the chemical assay of kelp.

What of chemistry in the 'older' universities? Mickleburgh, who had been appointed to Cambridge shortly before Cullen, went to Glasgow, gave way to John Hadley (1731–64), and he in turn to Richard Watson (1737–1816), afterwards Bishop of Llandaff, who was appointed professor of chemistry at Cambridge in 1764. At the time of his appointment it was said of Watson that "he knew nothing at all of chemistry, had never read a syllable on the subject, nor seen a single experiment in it". In two years the illustrious Black was to succeed Cullen at Edinburgh. Small wonder that the evolution of chemical science in the two countries was so different. Yet Watson was no idle churchman. He took his new appointment very seriously, and has related how at one period his conscience forced him to burn his chemical writings lest he be lost to the church altogether. Among other activities, he took steps to make the occupancy of the chemical chair more secure by persuading the Crown to make an annual grant of £100. It should be noted that initially there was no stipend attached to the chair that Cullen and Black occupied. They were remunerated by their students' fees and the takings of private medical practice.

Despite his inauspicious start, Watson was the first Cambridge chemist to evince any interest in the advance of industry based on exact chemistry knowledge which was taking place in various parts of the country. His "Essays", published in 1784–88, contain useful pictures of various industries, particularly on coal, lead and zinc, and his researches on charcoal production for gunpowder by closed distillation of

wood are known to have saved the Government large sums of money.

Black's influence was transmitted throughout the civilized world by the appointment of his students to influential positions in the academic and industrial world. Black was to Edinburgh what Boerhaave was to Leyden Not only did his students, Robison, Irvine, Hope, Cleghorn, and Thomson, follow him in the lectureship at Glasgow and chair at Edinburgh, but also others founded chemical schools throughout the country and abroad. Ogilvie went to Aberdeen, Thomas Garnett to the Andersonian University of Glasgow, J. Morgan and B. Rush established the teaching of chemistry at Philadelphia. Wm. Henry, the Manchester chemist, studied under him, as did Sir Humphry Davy's brother John. Humphry regretted that it had not been his own good fortune to study under Black. But of particular importance here is that two of his students had a vitalizing effect on the lethargic schools at Cambridge and Oxford. Let us follow the evolution of Oxford after the death of Mayow referred to above.

Oxford chemistry did not recover easily from the loss of Mayow, although one might have expected the Ashmolean foundation to bring about a revival. A number of chemists followed in the laboratory established by Elias Ashmole (Robert Plot, Edward Hannes, John Freind, Richard Frewin), but none of them succeeded in establishing any sustained teaching or research school.

"The reason for this sterility was not far to seek. The Oxford contemporaries of Newton had not the enquiring mind; the most brilliant of her sons devoted their genius to other ends and developed their talents in other places; those who stayed behind were content to accept the statements of others without testing them for themselves, and to pass on to their students information acquired at second-hand. The business of teaching was set higher than the duty of research" (R. T. Gunther, "Early Science in Oxford", 53.)

Ashmole's inadequate foundation was, from the chemical point of view, a failure, and chemistry continued to lag behind other expanding sciences No university professor was appointed, with the result that students who wanted to acquire some familiarity with the science had no one better to instruct them than the college fireman.

The only interesting outcome of the Ashmolean period is the association of John Wall (1708–76) of Merton with the foundation of the Worcester Porcelain Company (1751); but such a connexion cannot be considered adequate to compensate for the new low level to which Oxford intellectual life sank in the earlier part of the eighteenth century. Wall's connexion with Oxford was strengthened through his son, Martin Wall (1747–1824), delivering a course of lectures there from 1781 in the capacity of public reader in chemistry'.

The next development in the chemical history of Oxford was of great importance (corresponding as it did with the appointment of Smithson Tennant to Cambridge): it was the appointment of Thomas Beddoes (1760–1808), also a student of Joseph Black's at Edinburgh, to be reader in chemistry. Beddoes was only at Oxford from 1788 until 1793, but for a time at least chemical interests there were stirred up by his enthusiasm; and it is on record that such was the revitalized interest he created that attendance at his lectures exceeded anything known in the University since the thirteenth century. Here in Oxford was the vivid effect of Black's infectious personality re-enacted. Beddoes' short readership in chemistry was but a phase in his life, and the Pneumatic Institute at Bristol which he founded spread Black's influence in another direction. It cannot be said that Beddoes short sojourn at Oxford led to any great chemical efflorescence; but in 1803 a professorship of chemistry was endowed, and with it the establishment of regular teaching, something that had been in progress in Edinburgh for almost a century.

Cambridge was rather more fortunate than Oxford with its chemists. Richard Watson was followed by Isaac Pennington, and he in 1793 by W. Farish, who like Cullen in Glasgow lectured on the "Application of Chemistry to the Arts and Manufactures of Britain". In Farish's lectures we see a swing-over to an appreciation of the important contribution that chemistry was making to the industrial revolution. They covered smelting metallic ores, the uses of coal, such industrial chemicals as sulphur, alum, salt, acids, and alkalis, the chemical arts of bleaching and preparing cloth, and the production of mordants, etc. This highly practical approach heralded the further break with tradition, namely, the appointment of a chemist trained in the Scottish schools to the Cambridge chair. In 1813 Smithson Tennant (1761–1815), who had been in Cambridge since 1782, was appointed to the vacant chair of chemistry.

By this time Scottish chemistry, nurtured in the faculties of medicine at Edinburgh and Glasgow, had achieved a European reputation, and so the successors of Cullen and Black had an assured flow of talented students out of all proportion to that which came to Tennant and Beddoes, despite the latter's popularity as a lecturer.

When Black went to Edinburgh from Glasgow, he was succeeded by J. Robinson (1739–1805), and he in turn by William Irvine (1743–87), both students of his own. Irvine died in 1787, and was succeeded by Thomas Charles Hope (1766–1844). Hope only occupied the chemistry lectureship for four years before transferring to the chair of medicine, but his interest in research and his ability as a teacher maintained the reputation of the Glasgow school built up by Cullen and Black, whom he ultimately followed at Edinburgh as well (1799). Hope added still another of the elements (strontium) to be discovered by Scotsmen. On his translation to medicine he was succeeded by Dr. Robert Cleghorn (1777–1821), who continued to lecture on chemistry until an independent chair was founded in 1818.

This was an era of great industrial development by the application of chemistry to the arts in Scotland, during which the link-up between industrialists and universities was further strengthened. One need only mention in passing the introduction of chlorine bleaching at Gordon Barron and Company's Woodside Works through the activities of Prof Patrick Copland (1749–1822), professor of natural philosophy in Marischal College, Aberdeen; the production of the dyestuff *cudbear* and the development of turkey red dyeing by George and Charles Macintosh, the latter a student of Black; the patenting of bleach liquor and bleaching powder in the name of Charles Tennant of St. Rollox, and the general contribution made by the Tennant-Macintosh nexus in the way of heavy chemicals and ancillaries to the dyeing and finishing trades. Under Hope's influence the development of chemistry was rapid and of increasing economic importance. On account of his professional

contacts, Hope in some ways occupies a place of equal importance with Black, because increasing numbers of industrialists (for example, the Tennant and Macintosh group) were in a position to benefit by contact with chemistry in the universities of Scotland. The popularity of chemistry with all classes in Scotland became so great that Hope sometimes had five hundred students attending his lectures, and outside the University, interest was every bit as great. He continued to lecture until 1844, when he was succeeded by Dr. William Gregory as independent professor of chemistry, fully a quarter of a century later than the foundation of an independent chair in the more highly industrialized city of Glasgow.

LONDON'S WATER SUPPLY: SAFEGUARDING ITS PURITY IN PEACE AND WAR*

By Lieut.-Colonel E. F. W. MACKENZIE, O.B.E.

Director of Water Examination, Metropolitan Water Board

History

NO story of London's water supply would be complete without some brief account of the historical background from which have emerged the methods of purification which now form our vital defences against the transmission of the germs of water-borne disease.

Prior to the fourteenth century, the citizens of London obtained their water from the River Thames and its tributary streams, or from springs and wells, which were plentiful. At that time the supply of water was a duty of the City Corporation, and it remained so until 1582, when a Dutchman named Peter Morrys was granted a 500-year lease at the nominal charge of 10*s*. per annum, with the right to supply water drawn from the River Thames by pumps driven by water-wheels set in one of the arches of the old London Bridge. This undertaking remained in the hands of the Morrys family until 1701, when it was transformed into a company, which also acquired the city conduits. Thus was the duty of supplying water to London relinquished by the constitutional authority and handed over to private enterprise.

The next incident of note was the construction of the New River, opened in 1613, to convey pure water from springs in Hertfordshire to the City. The success of the New River Company led to the granting of power by Parliament to other companies for the purpose of supplying water, and between the years 1669 and 1806 no fewer than seven such companies were promoted. At the time of their formation, those of the companies which drew water from the River Thames had their intakes in the tidal pool, which became increasingly polluted by the ordure of the City. This led to the succession of serious epidemics of cholera in London during the nineteenth century.

Meanwhile, however, two important measures had been taken: first, the introduction in 1826 of filtration through sand, and second, the passing of the Metropolis Water Act of 1852, which prohibited the abstraction of water from the River Thames below Teddington Weir and imposed, as a legal obligation, the filtration of all river-derived water and the covering of service reservoirs. The Metropolis Water Act of 1871 further contributed to the cause of purity by the appointment of an impartial water examiner who transmitted the reports of the analyst, at that time Prof. Frankland, to the Local Government Board, and who had other duties mainly inspectorial in nature. The water supply, however, continued to be the subject of public agitation, which culminated in the passing of the Metropolis Water Act of 1902, by which the Metropolitan Water Board was created to take over from the companies the duty of supplying water to London.

The Act of 1902 also placed upon the Board certain duties in connexion with laboratory examination designed to ensure the safety of the supply. This was the genesis of the present Water Examination Department, which came into being in November, 1905, with the appointment of Dr. (afterwards Sir) Alexander Houston as the first director. There were, thus, two persons whose duty it was to safeguard the purity of the supply: first, the water examiner, who was an officer of the Local Government Board; and second, the director of water examination, who was an officer of the Metropolitan Water Board. This state of affairs continued until the appointment of water examiner was abolished in 1921, and the duty of safeguarding the purity of the supply thus devolved entirely upon the director of water examination. In 1904 the Metropolitan Water Board finally took over the private companies, and the duty of supplying water to London was taken out of the hands of private enterprise and restored once more to the control of the representatives of the people, by whom it had been voluntarily surrendered more than two centuries before.

Methods of Purification

Until 1909, filtration through slow sand filters was relied upon for the purification of the river-derived water. Sir Alexander Houston, however, was responsible for the introduction of a number of revolutionary changes, chief among which were the regular use of water which had been purified by passage through a storage reservoir (1909), chlorination (1916), the use of primary mechanical filters antecedent to slow sand filtration (1923), and the use of ammonia as a means of reducing the tastes produced by chlorine alone.

The Metropolitan Water Board now comprises twelve filtration works and some sixty well stations. It supplies an area 575 square miles in extent containing more than 7,000,000 people. The water is supplied through a distribution system of pipes 8,000 miles in length. Approximately two-thirds of the water is derived from the River Thames, one-sixth from the River Lee, and one-sixth from deep wells sunk in the chalk.

The wells are usually of great depth and the water delivered from them is of excellent physical quality. For many years it was supplied without any treatment, but the increasing urbanization of the country districts around London and the excessive pumping which now takes place has led to a progressive deterioration in the quality of the water lying in the great chalk basin beneath London, and this has necessitated the chlorination of all well-derived water, but no other treatment is required.

The river waters, on the other hand, are heavily polluted and require somewhat elaborate purification.

* Substance of a discourse delivered at the Royal Institution on December 8.

Briefly, the methods employed at the outbreak of war in 1939 were storage followed by filtration and chlorination.

The high rate of filtration made possible by the use of primary filters had detracted from the efficiency of the slow sand filters and had made it necessary to reinforce the purification processes at some works by the use of chlorine both before and after filtration This prefiltration treatment has conveniently been termed 'prechlorination'.

These methods enabled the production of water in keeping with the standards of bacterial purity widely accepted prior to 1939. In that year, however, a more stringent test of purity received authoritative approval, and immediate steps were necessary to bring the water to the desired level. This involved the use of prechlorination at all filtration works, together with certain adjustments designed to render it more efficient, and an increase in the terminal dose of chlorine to a point at which it is, at times, liable to give rise to some taste in the water when it reaches the consumer. With this exception the methods have proved successful, but it will be possible to surmount the difficulty of occasional chlorinous tastes without some sacrifice in purity only by the construction of large tanks in which the water may be retained, before delivering it to consumers, for a sufficient time to enable a small dose of chlorine to do the work for which, at present, a comparatively large dose is required. The construction of these contact tanks has not been possible during the War, but it has become the accepted policy of the Board that they shall be provided when circumstances permit.

Unfortunately, chlorinous tastes are not the only ones with which water engineers are afflicted. The river waters have tastes which vary from 'earthy' to 'mouldy'; the reservoirs are subject to algal growths which, by the liberation of essential oils, impart a wide range of tastes which have been variously described, the most common being 'aromatic', 'fishy' or 'grassy'. Until recently their complete elimination has been difficult or impossible, but the adaptation of activated carbon to waterworks practice has opened up a new field for the removal of tastes. Up to the present, it has necessarily been used by improvised methods, but it is hoped that it will be possible, after the War, so to adapt the works as to render this valuable treatment fully effective. The complete elimination of tastes from London's water supply should then be possible.

The Board has provided in the most ample manner for the statutory requirements in regard to water examination set forth in the Act of 1902. The Laboratories in Clerkenwell which were opened in 1938 are an outstanding example of a building which, in the highest degree, combines utility with architectural and artistic merit. Every unit in the building has been designed for a special purpose, and serves that purpose with the utmost efficiency. A high proportion of the staff have devoted most of their lives to particular aspects of water analysis.

The routine control of quality is exercised by the daily examination of samples representing the water in every stage of purification. Widespread random sampling from mains and consumers' taps throughout the area of supply is also practised, and enables the quality of the water as received by the consumer to be kept under frequent observation.

During the year 1943 no fewer than 38,351 such routine analyses were made. The work of the department is, however, by no means limited to this routine. Constant researches are made for improved methods, and special investigations are performed for the elucidation of purification and other problems which arise in connexion with the works. These have, in the past, contributed much to the sciences of water analysis and purification.

War and the Water Supply

Before describing the measures which were taken to protect the water supply of London against pollution from war damage, it would be well to picture what might have been the consequences had the water from one of the Board's major works become infected with the germs of typhoid, which is now, in England, the most to be feared of all the water-borne diseases.

Judged by past epidemics, it might be expected that infection of a filtration works of average size would, at the lowest estimate, result in 16,000 cases of typhoid with 1,600 deaths and the establishment of between 300 and 800 permanent carriers of the disease, as a reservoir of infection for the creation of further outbreaks. The significance of this can best be appreciated by comparison with the Croydon epidemic of 1937, in which there occurred 323 cases and 43 deaths Many will recall the widespread feeling of alarm and the sense of insecurity which prevailed among those residing within the area affected by this comparatively minor outbreak.

It is easy to picture what might have been the effect upon the morale of the people of so disastrous an occurrence, and of the knowledge that each such incident would increase the probability of further similar epidemics.

High in the order of priority for protective measures came the necessity of ensuring that there should be no interruption in laboratory examination and control of the supply, for without this there would have been no means of assessing the need for, or the success of, other measures. Among the first steps to be taken were the selection of suitable buildings in comparatively safe areas and their conversion into alternative laboratories.

The use of prechlorination was extended to all filtration works. This increased the main lines of defence to four, namely, storage, prechlorination, filtration and terminal chlorination This was undoubtedly the most important factor in preserving the purity of the water pumped from the works, for there was no occasion upon which less than two of these lines remained intact.

The residual chlorine in the water passed into supply was increased to the highest level consistent with the avoidance of serious cause for complaint. This provided against pollution through infiltration of ground-water into broken filtered-water channels and also gave some protection against failure to effect complete sterilization of fractured mains as a result of either physical difficulties, which often existed, or the fallibility of human nature. The value of residual chlorine has frequently been exaggerated; but its limitations were fully appreciated and its presence was not permitted to allow of any relaxation in the more positive methods of protection.

The possibility of the introduction of chemical poisons into the water either deliberately, or accidentally, as by the use of poison-gas bombs, was countered by a system of guards at works and reservoirs, and by arrangements for the immediate testing at the works for poisons should there be any suspicion that the water might have become contaminated.

It will be evident that chlorination was to play a most important part in our defensive measures, and it was necessary that every possible step should be taken to prevent any interruption in this vital process. Although chlorination had been in use by the Board for a considerable time, it was still regarded as somewhat subsidiary to the older purification processes. This view had now to be revised, for acts of war might at any moment have rendered it the most important or, indeed, the only barrier against the spread of water-borne diseases. A wholesale programme of reconstruction was planned and received the immediate approval of the Board. This work involved the detailed consideration and replanning of more than 150 chlorination points.

There could be no doubt that the most serious danger would be created by the fracture of water mains and sewers in close proximity in the streets, resulting in the admission of sewage to the water mains. Protection against the consequences of such incidents was provided by the rapid closure of valves by turncocks and by instructions to the effect that no main should be put back into supply after repair until it had been thoroughly flushed and disinfected by chlorine. Whenever possible, repaired and sterilized mains were examined bacteriologically before being restored to supply, but frequently they were so urgently required for fire fighting that this could not be justified. Sterilization by chlorine was, however, never omitted. Special mobile chlorinators were provided, and the whole of London was divided into areas to each of which some were allotted. Central control was maintained and a reserve of chlorinators was held directly under my orders, thus enabling relief to be provided in districts where the work was exceptionally heavy. Some difficulties in the rapid sterilization of mains were encountered in the early days, due chiefly to the almost complete disorganization of communications, but these were rapidly overcome and, as experience was gained, the whole organization worked smoothly and without avoidable delay.

It was not only necessary to conserve the purity of the supply. When the enemy resorted to fire raising, quantity became second only in importance to purity, for, without water, London might have been destroyed by fire. The greatest need for water frequently coincided with heavy damage to the works and consequent limitation of their output. Decisions had to be taken, often on the spur of the moment, as to the extent to which orthodox methods of purification might be discarded to increase production without imperilling the health of the people. There is no hard and fast line between a safe and an unsafe water, and such momentous decisions were not easily taken, for they had, of necessity, to be based upon personal opinion. It must be admitted that the taking of them was assisted by the gravity of the situation, and it can fortunately be said that there was no occasion when the quantity of pure water available was insufficient, nor was there, at any time, any deterioration in its bacterial purity. Local shortages there were, but these were due to the immense damage to the mains; and this was remedied with remarkable rapidity by the engineering staff of the Board.

Emergency Water Supplies

It was evident that, whatever precautions might be taken, interruption of piped supplies might occur. Arrangements were therefore made to deliver pure water by tank wagons and to provide emergency supplies if necessary from private wells and casual surface water sources. An organization was set up for the purification of these waters, which entailed the training in emergency purification methods of more than 7,000 volunteers.

During the aerial attacks on London, almost every conceivable form of damage which might have prejudiced the purity of the supply was inflicted upon the undertaking. Damage to sewers in the outskirts of London necessitated the discharge of untreated sewage into the rivers from which raw water supplies were drawn; reservoirs were cut off from the works by the destruction of aqueducts, thus necessitating the passing of unstored raw river water on to the filters; bombs fell into the filter beds and caused short-circuiting between the unfiltered and the filtered water channels. At times it was necessary to bypass the slow sand filters to enable the supply for fire-fighting to be maintained. Damage to the distribution system was particularly severe. In one night alone, more than five hundred mains were fractured and many became heavily charged with sewage.

All the necessary protective measures were, however, in readiness, and there is not a shred of evidence that the water supplied to London was at any time less safe than before the War. During the four years 1940–43, bacteriological analyses were performed on more than 50,000 samples drawn at the works, from mains pumping water into supply and throughout the distribution area, particularly in those localities where bomb damage had been heavy. Of these 50,000 samples, 99·3 per cent showed the absence of *Bact. coli* in 100 ml., that is to say, they conformed to the highest standard of bacterial purity despite the extensive damage which was frequently inflicted and the many opportunities for dangerous pollution which were created. This represents a purity, during those years of war, higher than ever before, and it has never been suggested by any health authority that a single case of disease occurred in London which might have been attributed to the water supply.

POLYMER-PLASTICIZER INTERACTION

By ELIZABETH M. FRITH and R. F. TUCKETT,
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AT a meeting of the Plastics Group of the Society of Chemical Industry on November 17, 1944, polymer-plasticizer interaction was discussed. Owing to the wide range of the discussion and in view of topical interest in this subject, it has been thought desirable to present here a preliminary account which covers some of the points raised; more detailed papers will appear elsewhere. Some such general account seems to be overdue, as previous ideas on the subject would seem to need revision as a result of recent advances in polymer thermodynamics.

Though all thermoplastic polymers soften on heating, they also, in common with other organic compounds, tend to decompose as well. Moulding temperatures for any particular polymer must therefore be chosen to suppress this decomposition as much as possible. Some polymers can be moulded with negligible decomposition, whereas with others the temperatures required for moulding are too high,

even with the intelligent use of anti-oxidants. Historically, plasticizers were first used in a systematic manner in order that intractable polymers might be moulded at temperatures which were not too damaging; their purpose was to make the composition more plastic (or less viscous) at a given temperature, and the name 'plasticizer' perpetuates this property, though the fact that the elastic properties were also profoundly altered was soon realized.

To explain the action of plasticizers, it is necessary to start with the current picture of an amorphous polymer, which is that of a tangled collection of randomly kinked long-chain molecules; if certain reasonable assumptions are made about the flexibility of each chain, this qualitative picture can be transformed into a formal model in terms of which many of the observed properties of polymers can be described. These properties are a consequence of the tangled structure, and the effect of a plasticizer is presumably to break down or loosen this structure. Early theories of plasticizer action, allowing for this, suggested that the plasticizer acted as an internal 'ball-bearing' or lubricant by virtue of which neighbouring portions of polymer could slide over each other more rapidly. Though satisfying to the mechanically minded, the physical chemist finds such a picture inadequate, for, besides not accounting for the specificity of plasticizers, it completely avoids the crucial problem of how the plasticizer is distributed throughout the polymer. Is it a discrete physical mixture, like sand and sugar, or does dispersion on a molecular basis form a solution of plasticizer in polymer? In fact, any mechanical theory leaves for later consideration whether the 'ball-bearing' is a single molecule, a discrete visible droplet or anything between these two extremes.

It is now realized that plasticizers can belong to either of the above two main classes, these being termed non-solvent and solvent types respectively. Two of the oldest plasticizers for nitro-cellulose form conveniently contrasting examples of these. Castor oil is a non-solvent plasticizer and is dispersed in the nitrocellulose as discrete droplets which are sometimes visible with a microscope; many rubber 'extenders' also come into this category. As a result of internal diffusion in the plastic, droplets of non-solvent types will tend to coalesce to larger aggregates and ultimately to 'sweat out'. On the other hand, a typical solvent plasticizer for nitrocellulose is camphor; this is dispersed as single molecules forming a true solution, in contrast to the two-phase system of the non-solvent type. For the above reason, solvent plasticizers are preferable for nearly all purposes, and these are now discussed further; for the moment, only amorphous polymers and liquid plasticizers are considered.

Previously it has been hard to accept the idea of a plasticizer dissolving in a polymer owing to difficulties in visualizing the nature of the solution. To disperse a plasticizer molecularly, it was thought necessary to assume a specific attraction between the plasticizer molecule and the polymer unit, many references to a polymer-plasticizer complex being found in the literature. Similarly, the physical fact that raw rubber swells and finally dissolves in a solvent like benzene tends to reinforce the view that there is a relatively strong polymer-solvent interaction compared with the polymer-polymer one, and that this is the main factor influencing the swelling and solubility of macromolecules[1]. Recent work has tended to deny this view completely, and also explains why different plasticizers have different compatibilities with a specific polymer.

From the point of view of solubility, a polymer is now considered as a liquid; hence polymer-plasticizer (or polymer-solvent) mixing is exactly similar to that of two simple liquids and subject to the same thermodynamic principles. Two liquids will mix to form a single phase only if there is a decrease in Gibbs free energy as a result of the mixing process, that is, $\Delta G < 0$. Now, the decrease in Gibbs free energy can be split into the usual heat term and entropy of mixing term ($\Delta G = \Delta H - T\Delta S$). In the case of a polymer dissolving in a solvent, experiment reveals that ΔS is generally abnormally large and positive. The theoretical reason for this was first suggested by Meyer[2]; it is due to the fact that a long-chain molecule in solution can take up a large number of distinguishable configurations. This circumstance alone provides a large positive mixing entropy which is sufficient by itself to bring about solution. A polymer-plasticizer complex (and similarly a solute-solvent one in a liquid mixture) means that the heat term ΔH is strongly negative and therefore assists solution, instead of being positive as it is for most binary mixtures. ($\Delta H > 0$ corresponds to absorption of heat on mixing.) With polymers, the presence of a large positive ΔS means that it is unnecessary to invoke any specific interaction with the plasticizer to explain the solution process.

Meyer's original suggestion was formalized into a definite model the statistical thermodynamics of which were worked out independently and simultaneously by Flory[3], Huggins[4] and Miller[5] for the case $\Delta H = 0$ with essentially similar results; the more difficult extension for $\Delta H \neq 0$ has recently been made by Orr[6] and Guggenheim[7] The results show that, provided ΔH is not too large, ΔS is almost independent of it (A similar result holds for simple liquid mixtures and is the basis of Hildebrand's regular solution approximation[8].) It follows from this that if ΔH is strongly positive, then ΔG can also become positive; hence the mixture of polymer and plasticizer will separate into two phases. The theory predicts that one of these will be swollen polymer and the other almost completely pure plasticizer, in agreement with experiment[9]. Hence, at a given temperature, the composition of the swollen phase is the maximum amount of plasticizer which can be incorporated in a polymer for that specific pair of substances. Any excess plasticizer will 'sweat out' and form a separate phase similar to a non-solvent plasticizer It seems possible that some of the evidence in the literature of polymer-plasticizer complexes containing 20–30 per cent plasticizer may be due to incompatibility effects of this type.

The problem has thus resolved itself into a measurement of the heats and entropies of mixing (or dilution) of a polymer with a plasticizer, with the emphasis on the heat term. In theory, relative vapour pressure measurements of the plasticizer in the polymer will give all the required information, provided a sufficiently large concentration and temperature range is covered. The heats involved are, however, small and therefore subject to large relative errors; even under the most favourable conditions, as in Gee and Treloar's classic study of the rubber-benzene system[10], the probable error in the estimated heat of dilution is $\pm$ 30 per cent[11]. In studying differences between plasticizers, which are usually chosen to have a very small vapour pressure, this line of attack is distinctly unpromising and will remain so until

pressures of 10^{-2}–10^{-1} mm can be measured with as much precision as those of 10–100 mm Direct measures of the equilibrium swelling or the total heat of mixing are difficult with 'hard' plastics, such as polyvinyl chloride, as equilibria are reached very slowly.

For the above reasons, it has been necessary to develop indirect methods of estimating ΔH, and even so, only relative results can be obtained. One method relies on the assumption that the polymer-plasticizer heat of mixing is proportional to the corresponding monomer-plasticizer heat effect. This is a pure assumption, though a reasonable working one, and can perhaps be checked later by heat of dilution measurements on a low polymer. The problem then becomes a measurement of the mixing heats between plasticizer and monomer, which is feasible experimentally; with vinyl polymers, the saturated monomer is preferred to avoid double-bond complications, for example, ethyl benzene for polystyrene. A second method uses the concentration variation (c) of the specific viscosity (η_{sp}) of dilute solutions of polymers as a measure of ΔH. Alfrey, Bartovics and Mark[12] found that, for a given polymer, both the limiting value of η_{sp}/c at zero concentration and the slope of the $\eta_{sp}/c - c$ line were dependent on the solvent; 'good' solvents increased both the slope and the intercept, whereas 'bad' ones depressed them. The concept of 'good' and 'bad' solvents can be formulated thermodynamically and a semi-quantitative treatment of the viscosity effects has been developed[13]. It is not often possible to measure dilute solution viscosities in pure plasticizers; to get over this difficulty, the polymer is dissolved in a mixture of 'indifferent' solvent ($\Delta H = 0$) and plasticizer. The slopes of the $\eta_{sp}/c - c$ lines vary with the plasticizer used in the solvent mixture and are in agreement with their known plasticizing properties with a given polymer. Though the theory of the effect is admittedly not complete, the method is probably the most convenient one for estimating relative interactions. The light scattering of polymer solutions[14] is a possible means by which interactions might be studied in the future, but the technique is still in its infancy; the published results suggest a strong dependence of the effect on solvent type.

So far, discussion has been confined to polymers which are completely amorphous. For crystalline bodies, the total free energy change for the solution process can be split into two stages: (1) melting of the crystals to give an amorphous polymer (ΔG_{melt}); (2) mixing of the amorphous polymer with the plasticizer ($\Delta G_{mix.}$). For amorphous polymers, (2) is the only relevant process and the factors governing $\Delta G_{mix.}$ have already been discussed. If the melting range of the crystalline polymer is above room temperature, then ΔG_{melt} will be positive; its magnitude will depend on the interval between room temperature and this range. For a high-melting polymer ΔG_{melt} can become larger than $\Delta G_{mix.}$ for most solvents, in which case the crystals will be completely insoluble at low temperatures, as the total free energy change is positive. For this reason, crystalline polyethylene is insoluble in nearly all solvents at room temperature. As the temperature is raised, the melting range is reached in which there is an appreciable proportion of amorphous material in thermodynamic equilibrium with the crystalline regions[15]; this amorphous polymer is miscible with solvents, and the rapid increase in polyethylene solubility in nearly all solvents at about 70° C. is due to the operation of this factor. In such circumstances, a plasticizer will tend to dissolve in the amorphous regions and leave the crystalline ones untouched; only a strong relative attraction ($\Delta H < 0$) between plasticizer and polymer link will cause the crystalline regions to dissolve.

In the foregoing paragraphs, an attempt has been made to give the thermodynamic background of the polymer-plasticizer compatibility problem. Such an approach does not give any information at all about the relative plasticizing efficiency of two compatible substances—this is not surprising as it forms a completely unrelated problem. The efficiency of a plasticizer is now suspected to be almost completely determined by the size and shape of its molecule, but a large amount of accurate data is required before this problem can be pursued further.

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OBITUARIES

Dr. D. S. Raitt

THE tragic death of Douglas Raitt as the result of a motor accident on October 4, 1944, at the early age of forty-one, will be deeply regretted not only by marine biologists but also by the general public, for apart from his scientific attainments, he had wide cultural interests and was recognized as a successful broadcaster and as a composer of Scottish songs. In particular, fishery research has lost a most promising worker, who had a brilliant career before him.

Born in Aberdeen on January 18, 1903, Raitt was educated at Robert Gordon's College there and at the University of Aberdeen. In the University he came under the influence of Prof. J. Arthur Thomson, who undoubtedly did much to foster in him originality, precision in workmanship and a philosophic outlook on life. Immediately after graduating B.Sc. in 1926, he was appointed a probationer naturalist on the scientific staff of the Fishery Board for Scotland, being placed on the established grade two years later.

With the resumption of fishery research after the War of 1914–18, the study of haddock in all its aspects was delegated to Scotland by the International Council for the Exploration of the Sea, and Raitt joined the Scottish team of workers so ably led by Dr. A. Bowman, then scientific superintendent. His first contribution to the series of publications was on the fertility of the haddock. After the transference to Newfoundland of Dr. Harold Thompson, who had carried out brilliantly the survey of the haddock material and laid the foundation of the work, Dr. Raitt was given the task of continuing the research and producing forecasts of the future yield of the stocks, largely for the benefit of the fishermen and the trade. This led to the appearance of a series

of valuable papers published by the International Council and by the Fishery Board for Scotland (now the Fisheries Division, Scottish Home Department), two of the most important being "The Haddock Stocks of the North-East Atlantic" and "The Rate of Mortality in the North Sea Haddock Stocks"—the latter a definite contribution to the overfishing problem. These researches gained for him the D.Sc. in 1937. In 1939 he was appointed Buckland lecturer for 1940 to deliver a series of lectures on the haddock, but owing to the outbreak of war the lectures were never delivered

Raitt was a fellow of the Linnean Society and of the Royal Society of Edinburgh and published papers on various aspects of marine life in different scientific journals. In one of these he described a new species of sandeel from British waters—no mean achievement these days.

He had a great gift for organizing and staging shows and was largely responsible for two fishery exhibits put up by the Fishery Board for Scotland at Aberdeen and Glasgow, which were designed to illustrate the practical aspect of marine research as carried out by a Government department The film "Sea Food", a record of the methods carried out at sea by the research vessels and in the laboratory, was also supervised by him.

During the present War, he was seconded to the Ministry of Home Security and held important posts under the district commissioners at Inverness, Edinburgh and Dundee.

He is survived by Mrs Raitt and two sons.

R. S. CLARK.

Prof. Gustav Cassel

PROF. GUSTAV CASSEL, whose death at the age of seventy-eight occurred on January 14, was beyond doubt one of the outstanding figures in economic science during the inter-war period. His authority was second only to that of Lord Keynes, and his advice was eagerly sought on many occasions by his own Government and by foreign Governments. He played an active part at many international monetary conferences during the 'twenties and early 'thirties, and was head of the Swedish delegation to the World Economic Conference of 1933.

Prof. Cassel occupied the chair of economics at the University of Stockholm, and his "Theory of Social Economy" will always rank with the outstanding works on economic theory. First and foremost, however, he was a monetary specialist. His most important contributions to economic science were in the monetary sphere. In particular, he secured his place in posterity as the leading theoretical expert on foreign exchange during the chaotic period that followed the War of 1914–18. In his "Money and Foreign Exchange After 1914", he put forward the theory that under a system of inconvertible paper currencies the exchange-rates tend to represent the ratio between the internal price levels of the countries concerned; in other words, they tend to adjust themselves towards what he called their "purchasing power parities". When he first sought to popularize this conception, it was regarded as almost revolutionary, and the time-honoured theory according to which exchange-rates are determined by the trade balance died hard. He lived to see, however, the general acceptance of his principle.

In the sphere of monetary policy, Cassel was strongly opposed to deflation, and advocated low interest-rates during the late 'twenties and early 'thirties As a member of the Gold Committee of the League of Nations, and in his various writings, he was concerned by the inadequacy of the volume of monetary gold to meet the requirements of expanding world production and trade. In 1937, however, Prof. Cassel, together with many other theoretical and practical experts, was misled by an apparent excess of gold supplies into a panicky advocacy of a deflationary policy.

Prof. Cassel did not believe in the device, so popular among many economists, of seeking to impress his readers by indulging in obscurantism. His books and articles were written for the most part in simple, clear language, understandable to the intelligent layman at the same time as being inspiring to the expert.

P. EINZIG.

Mr. E. Rothbart

ERWIN ROTHBART, acting lecturer in economic statistics in the University of Cambridge, who was killed in action in Holland in December 1944, aged thirty-one, was a refugee from Nazi Germany and an expert in economic theory and statistics; he specialized in the theory of industrial fluctuations and economic development.

Despite his originality, he had published little: his reticence and his horror of superficiality were such that his best work is probably to be found in the mass of unpublished manuscripts which he left Some of these may be rescued for publication, but undoubtedly the more subtle of his ideas were still locked away in his mind. The quality of his thought was revealed in the penetrating book-reviews which he contributed to the *Economic Journal*, and in the formal and informal discussions on economic theory in which he took part with the younger economists at Cambridge and London.

Rothbart first became prominent in discussions in 1936 at the meetings held regularly by Profs. Robbins and Hayek at the London School of Economics. There, with A. P. Lerner, O. Lange, N. Keldor and M. Kalecki, he found himself one of a small group championing the latest theories of J. M. Keynes with an almost religious insistence. Two years later he was appointed research assistant in economic statistics at Cambridge, and in 1940 he took over the teaching of economic statistics, and continued it until he insisted on joining the Army.

Rothbart was a fine example of that combination of opposites, which is the rule rather than the exception in the workings of the human mind. Quick in thought, he was slow in action and self-expression. A self-taught mathematician, he delighted in the subtler turns of economic theory; yet his awareness of practical and political realities was no less acute. A lover of liberal values, his political sympathies were nearer to the hard discipline of the communists: with an impish love of life, he combined a recklessness that courted death. He leaves a widow and young son.

D. G. CHAMPERNOWNE.

WE regret to announce the following deaths:

Dr. Alexander Duckham, chairman and governing director of Alexander Duckham and Co., Ltd., lubrication technologists, on February 1, aged sixty-seven.

Prof. S. H. Gage, since 1908 emeritus professor of histology and embryology at Cornell University, on October 20, aged ninety-three.

NEWS and VIEWS

Sir John Orr, F.R.S., and the Rowett Research Institute

Sir John Boyd Orr's wide circle of friends will greatly regret that he has tendered his resignation from the directorship of the Rowett Research Institute after holding that post since its foundation, in which he took a prominent part. All over the world it is recognized that to a very large extent it was his vigorous and stimulating direction that made "the Rowett" one of the outstanding research centres where problems relating nutrition to agriculture have been studied. The wide recognition to-day that planned agriculture is the only sound foundation of a national nutrition policy is one direct result of Sir John's teaching and influence. His ideas prompted the appeal for "the marriage of agriculture and nutrition" that the Right Hon. Stanley Bruce made to the League of Nations on an historic occasion. They can be regarded, therefore, as having been prominently in the mind of those who called together the United Nations Conference on Food and Agriculture at Hot Springs, Virginia, in 1943. Whatever benefits to the world at large may ultimately be derived from what happened at that great conference will be related in the minds of many people with the views that have dominated everything that Sir John Orr has said or written during the past twenty years.

Sir John's own research has been mainly of protein and mineral metabolism. but he is perhaps best known to the general public for his published works on the nutritional needs of the people of Great Britain. A very deep impression was made just before the War by the appearance of his book "Food, Health and Income". The data presented in this work have been used by sociologists all over the world, but, perhaps, no more important use has been made of them than when they were adopted as a background against which a nutritional policy for Great Britain during the period of the War was planned. Among Sir John's many contributions to the advancement of nutritional science, there can be mentioned his establishment at the Rowett Research Institute of the Imperial Bureau of Nutrition and his foundation of *Nutrition Abstracts and Reviews*, of which he has been editor-in-chief since it first appeared. Sir John has been a member of many international and national committees dealing with matters concerning nutrition, more particularly in its relation to agriculture. He took an active part in the deliberations of the Technical Commission on Nutrition of the League of Nations and helped to draw up a number of the invaluable reports this Commission issued from Geneva. He served on the Advisory Committee on Nutrition of the Ministry of Health before the War and has since acted as chairman of the Scottish Scientific Advisory Committee. He was recently elected by a group of United States men of science to receive an award for the most outstanding work in the international field of nutrition. There will be everywhere an earnest hope that Sir John will continue to exert, perhaps in other spheres, the same powerful influence that he has exerted in the past. A great deal of enterprise and effort will be needed if the recommendations and resolutions of the Hot Springs Conference are to be implemented, even in the countries where the attitude of the politicians and the public is relatively enlightened towards social and economic problems. We understand that no successor at the Rowett Research Institute to Sir John Orr has yet been elected, but the post, which also carries with it the directorship of the Imperial Bureau of Nutrition and the editorship of *Nutrition Abstracts and Reviews*, will be advertised in due course.

Sir William Wright Smith

On February 2, at the Royal Botanic Garden, Edinburgh, Sir William Wright Smith, King's Botanist in Scotland, regius keeper of the Royal Garden, and professor of botany in the University, was presented with a portrait of himself, on the occasion of his seventieth birthday. Sir John Stirling-Maxwell presided, and the presentation was made by the Earl of Stair. At the same ceremony a second portrait of Sir William was presented to the Botanic Garden by Sir John Fraser. The portraits, which were painted by Mr Stanley Cursiter, were the gift of a large number of Sir William's botanical and horticultural colleagues and other friends. Sir William has been connected with Edinburgh since the beginning of his career. He was educated at the University, and was lecturer in botany there during 1902–7. In 1908 and 1909, he explored the vegetation of north-west Sikkim, and of the Tibet-Nepalese and the Sikkim-Chumbi frontiers, returning to Edinburgh in 1911 as assistant keeper of the Garden; in 1922 he was appointed regius keeper and professor at the University. Sir William's early explorations have given him a life-long interest in the mountain flora of India, Tibet and Nepal, and it is for his work on the classification and introduction of plants from those regions, notably primulas and rhododendrons, that he is best known to botanists and horticulturists all over the world. Under his genial direction, the great traditions of the Edinburgh Garden, and of the University Botanical Department, have been worthily upheld, and his many friends have welcomed this opportunity of showing him their admiration and affection.

Institution of Electrical Engineers: Faraday Medallist

The Council of the Institution of Electrical Engineers has made the twenty-third award of the Faraday Medal to Dr. Clifford Copland Paterson, past-president, for the conspicuous services rendered by him in the advancement of electrical science, particularly in the field of electrical research. The Medal is awarded not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence or membership of the Institution. On the staff of the National Physical Laboratory during 1903–19, Dr. Paterson took charge of the electrotechnical and photometric departments and was largely responsible for building up this section of the Laboratory. During the War of 1914–18 he participated in the inception and development of the Paterson-Walsh electrical height finder, which provided an automatic record of the heights of aircraft. He has been director of the Research Laboratory of the General Electric Company at Wembley from its inception, guiding the whole of its activities, which range from the heavy engineering field to electronics. His contribution to investigations into new methods

of artificial lighting and into electronic developments has been outstanding During the present War he has collaborated with the Armed Forces and with the Supply Departments on many matters of outstanding national importance. Dr. Paterson was elected a fellow of the Royal Society in 1942.

Honorary Member

THE Council of the Institution of Electrical Engineers has elected Mr. John Somerville Highfield, past-president, to be an honorary member of the Institution. This distinction has been conferred upon him in appreciation of his distinguished work in the development of the science of the supply and application of electricity. Mr. Highfield became chief engineer to Stafford and St. Helens, Lancashire, after which he was appointed chief engineer and manager of the Metropolitan Electric Supply Company. As senior partner in the firm of Highfield and Roger Smith, he later acted as consulting engineer for the Central Electricity Board and several large electricity undertakings and industries in Great Britain and abroad. He also became a director of the London Power Company, the London Associated Undertakings, the Central London Electricity Ltd., etc. Mr. Highfield originated the closed-bar system for switchgear, discovered the reason for the failure of high-voltage alternator windings, and introduced to England the Thury system of high-voltage D.C. constant-current generation and distribution. During the War of 1914–18 he demonstrated at sea the use of shrouded hydroplanes for submarine detection.

Engineering and the Future

MR. FRANK PARFETT delivered his second presidential address before the Society of Engineers on February 5. He stated that there is a widespread and growing opinion among professional engineers in favour of federation of their institutions in order to have co-ordination of policy and joint representation on matters which are common to the whole profession. During the past year, two committees, the members of which came from various institutions, have been concerned with this matter, one of them dealing with national and the other with international federation. Very shortly proposals will be circulated to the councils of the bodies concerned for their consideration. Referring to the possibility of conscription after the War, Mr. Parfett said that the problem for peace-loving nations when war comes is to be ready and active with the minimum time-lag. The training of engineering personnel must therefore not be wasted. Young engineers in the future who are required to have army training should be sent to military engineering centres, and at the end of their term they should be entered on the National Register according to the sphere in which they could best serve the country in a national emergency. Factories, means of production, and personnel should be so organized that in the event of war we can immediately change from peace production to war production. Among post-war improvements suggested by Mr. Parfett was that of road and street lighting. He believes that main and secondary roads throughout Britain should be so illuminated that individual lighting on road vehicles would be unnecessary and merely reserved for minor roads. In all general utility articles, the public should accommodate itself to the acceptance of mass-produced articles from standardized designs. This would allow methods of production to be improved, which is the only way in which industry will be able to meet the higher wages now being demanded Mass production does not mean the death of individual craftsmanship, for which there is still ample scope.

Conference on Science in War

THE Association of Scientific Workers is holding a Conference on "Science in Peace" on February 17–18 at the Caxton Hall, Westminster. The Conference is being organized in three sessions. The first, on Saturday afternoon, will deal with ways of securing an expanding economy and full employment The problems of the effects of science on the productivity of labour will be introduced by a member of the Amalgamated Engineering Union, and specialists in each field will discuss in detail how science can be used to develop the basic British industries. The second session will deal with the more internal problems of science. The needs of fundamental research, and of applied science and technology will be dealt with, and papers will be read on the training of scientific workers, the organization and finance of science and information services. The third session will deal with the way in which science can affect the everyday life of each individual. The topics to be covered are research into consumer needs, health, food and agriculture, building and homes, and the place of science in culture. Tickets for the Conference (*5s.* for the three sessions, *2s. 6d.* per session) and further information can be obtained from Mrs. B. Ryerson, Association of Scientific Workers, Hanover House, High Holborn, W.C.1.

Announcements

DR. HARLOW SHAPLEY, director of Harvard College Observatory, has been re-elected to the presidency of the Society of Sigma Xi, the American society for the encouragement of research in science. Dr. Frank B. Jewett, president of the National Academy of Sciences, has been elected member of the Society's national executive committee and Dr. M. C. K. Jones, of the Esso Research Laboratories, Elizabeth, N.J., is to be a new member of the national membership committee.

DR. B. A. KEEN, scientific adviser to the Middle East Supply Centre, has completed a second extensive tour of Middle East territories. He has now returned to England for further consultations, and the completion of his report on the problems of agricultural and rural development in that area.

DR. J. P. LAWRIE, senior press censor, Scientific and Technical Censorship, Ministry of Information, has, after five years service, resigned his appointment in order to take up new duties with the Royal Naval Scientific Service.

DR. HENRY DE LASZLO, managing director of L. Light and Co., Ltd., Old Bowry Laboratories, Wraysbury, fine chemical manufacturers, is visiting the United States, Mexico, Portugal and Spain. He will be making a survey of sources of organic intermediate chemicals manufactured in the United States, arranging for contracts for future delivery, and purchasing out of the way organic research chemicals not manufactured in Great Britain. Research workers and others requiring any particular substance are invited to communicate with Messrs. Light.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Sub-crystalline Changes of Structure Accompanying Thermal Transitions in Rochelle Salt, and in Potassium Dihydrogen Orthophosphate

ACCORDING to the classical derivation of the Phase Rule, a transition *point* in a one-component system involves the co-existence of three independent phases, with the same thermodynamic potential of the component in three independent equations of state. For equilibria involving two solid and one vapour phase, the requirement that the phases shall be 'independent' can be given a definite interpretation in terms of crystal structure. For example, if we start with a single crystal of rhombic sulphur, and gradually heat it to above the transition point with monoclinic sulphur, the crystal may appear to preserve its external form, but X-ray photographs would show that actually it breaks up into a mass of smaller crystals of the monoclinic variety. These would give powder rings with the monoclinic spacings, insofar as they are independent of the original rhombic lattice. Corresponding with this rearrangement of the molecules to form a new crystal structure independent of the original arrangement, there are finite changes of volume and heat content at the transition temperature between the two crystal forms.

Thermodynamic transitions involving changes from one crystal structure to another at a transition *point* are said to be 'of the first kind'. We would prefer to call them 'discontinuous'. X-ray pictures illustrating the change from single crystal to powder have been published for the change from β- to α-resorcinol[1], and have also been observed[2] for the change of structure in KD_2PO_4.

An increasing number of examples is accumulating[3] of thermodynamic transitions 'of the second kind', which might be termed 'continuous'. In these, finite changes of volume and heat content at a transition *point* are replaced by 'anomalous maxima' on the expansion and specific heat curves, as if the phase change were spread out over a range of temperatures. Although some of these phenomena have been interpreted by statistical thermodynamics, it has not hitherto been clear how 'continuous' transitions affect crystal structure.

We have found in the case of Rochelle salt[4], and more recently in the case of potassium dihydrogen orthophosphate, that a break-up of the single crystal into sub-crystalline regions actually does occur over the transition range of temperatures. These sub-crystalline regions are, however, orientated in a definite relationship to the original crystal, and the discontinuities between them appear to be insufficient to lead to the formation of independent small crystals. Moreover, the break-up is reversible, in the sense that if the crystal is heated above the transition range again, X-ray pictures show that the sub-crystalline regions coalesce, and that the specimen again possesses all the properties of a single crystal. A single crystal broken up in this way may conveniently be called a 'hybrid'.

Up to the present, observations have been made by oscillating single crystals in a low-temperature chamber, at a series of temperatures, and making accurate determinations of changes in lattice spacings by means of a multiple-exposure spectrometer[5]. Changes in intensities of X-ray reflexions have also been observed, but will not be described here.

For Rochelle salt, over the transition range which begins at $+24 \cdot 5°$ C. and terminates at about $-20°$ C., no break-up of single crystals is observed when reflexions from planes parallel to the c axis are measured. But reflexions from planes parallel to the a axis and approximately bisecting the angles between the b and c axes are split into two components of slightly different Bragg angle. These two components are most clearly separated at about the middle of the transition range, around 0° C. Their presence shows that over the transition range a 'single' crystal of Rochelle salt is in reality made up of sub-crystalline units, which all have their a axis in common, and their b and c axes respectively equal, but which differ in that the angle between these two axes is either 90° 2′ or its supplement 89° 58′ apparently at random. These b and c axes coincide approximately in magnitude and direction with the b and c axes of orthorhombic Rochelle salt above $24 \cdot 5°$ C.

It is noteworthy that if the 'single' crystal is cooled below about $-20°$ C., or is heated above $24 \cdot 5°$ C., the split reflexions coalesce again. The change from a single crystal to a hybrid crystal with these sub-crystalline domains can be brought about repeatedly by the appropriate temperature changes, though there is some evidence that with repeated treatment the size of the sub-crystalline unit decreases.

In the case of potassium dihydrogen orthophosphate, when a single crystal is cooled below the transition threshold[6] at $-158°$ C., by dripping liquid oxygen ($-185°$ C.) or liquid nitrogen ($-195°$ C.) on to it, a corresponding break-up into sub-crystalline units is observed, which is even more striking in order of magnitude. When reflexions from planes parallel to the a or b axes are examined, the crystal appears to be 'single' down to the lowest temperatures so far observed. On the other hand, a break-up into sub-crystalline units is apparent at both $-185°$ C. and $-195°$ C. when the crystal is viewed normal to the c axis. The sub-crystalline units all have the c axis in common, and their a and b axes are equal to each other, and approximate in direction and magnitude to the original axes in the tetragonal form. But the angle between these two axes can be either 90° 27′ or its supplement 89° 33′, apparently at random. As with Rochelle salt, the change from single crystal to hybrid and back again can be brought about repeatedly by the appropriate temperature changes.

Further details of the structure of these hybrid single crystals are being examined. But even the experimental evidence so far obtained offers a suggestive picture of the structural basis of continuous thermodynamic transitions. It seems likely that when the change of crystal structure which would be involved in the appearance of a new phase is sufficiently small to be accommodated within the original lattice by a sub-crystalline break-up, the single crystal changes into a hybrid, instead of breaking up into new crystals. From the point of view of the Phase Rule, no new equation of state independent of the original structure can be formulated, so that there is no sharp transition point.

It is hoped that further experiments on these hybrid single crystals will throw light on the hysteresis which frequently accompanies continuous thermo-

dynamic transitions, and also on the formation of 'thermal mosaics' in crystals[7].

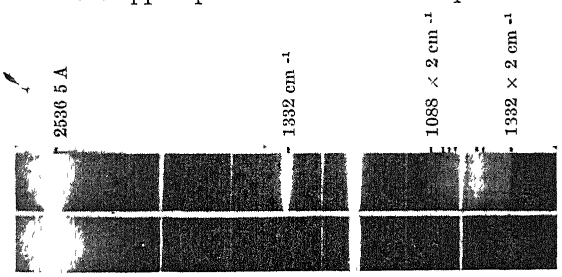
A R. UBBELOHDE.
I. WOODWARD.
Davy Faraday Research Laboratory,
Royal Institution, 21 Albemarle Street,
London, W.1. Dec. 20.

[1] Robertson and Ubbelohde, *Proc Roy Soc*, A, **167**, 138 (Figs 5–7) (1938)
[2] Ubbelohde and Woodward, *Proc Roy Soc*, A, **179**, 399 (1942)
[3] *Ann Rep Chem Soc*, **36**, 157 (1939), **37**, 167 (1940).
[4] In course of publication
[5] Ubbelohde, *J Sci Instr*, **16**, 155 (1939).
[6] Busch, *Helv Phys Acta*, **11**, 269 (1938)
[7] Oldham and Ubbelohde, *Proc Roy Soc*, A, **176**, 70 (1940)

Raman Spectrum of Diamond

THE new approach to the dynamics of crystal lattices made by Sir C. V. Raman[1] leads in the case of diamond to the result[2,3] that the atomic vibration spectrum of this crystal should exhibit *eight* distinct monochromatic frequencies. Of these, the highest frequency (1,332 cm.$^{-1}$ in spectroscopic units) corresponds to the triply degenerate vibration of the two Bravais lattices of the carbon atoms with respect to each other, this being *active* in the Raman effect. The other seven frequencies represent oscillations of the layers of carbon atoms parallel to the faces of the octahedron or the cube occurring normal or tangential to these planes with the phase reversed at each successive equivalent layer All the seven modes of vibration of this description are *inactive* in the Raman effect as fundamentals. The *octaves* of these frequencies may, however, appear as frequency shifts in the Raman spectrum, though with intensities extremely small compared with that of the Raman line of frequency shift 1,332 cm.$^{-1}$. Besides the octaves, various combinations of these frequencies may also appear in the Raman spectrum.

The new lattice dynamics thus predicts that besides the frequency shift of 1,332 cm.$^{-1}$ corresponding to the so-called principal or fundamental oscillation, numerous other frequency shifts appearing as sharply defined lines should manifest themselves in intensely exposed Raman spectra of diamond. This result has been strikingly confirmed in an investigation already reported by me[4]. Since then, I have recorded spectra of much greater intensity and much better resolved, with the aid of a large quartz spectrograph and an exceptionally large plate of diamond of the ultra-violet transparent type recently acquired by Sir C. V. Raman. Under the conditions employed and using the 2536·5 A. resonance radiation from a water-cooled magnet-deflected mercury arc in quartz as the exciter, the Raman line with frequency shift of 1,332 cm.$^{-1}$ is recorded with an exposure of only two minutes. With an exposure of 72 hours, a satisfactory picture showing what may be designated as the Raman spectrum of the *second order* is obtained. This is the upper spectrum shown in the reproduction herewith, the lower spectrum being that of the mercury arc recorded with comparable intensity. It will be noticed that a whole series of discrete Raman lines appear in the former, which stand out on a feebler background evidently made up of unresolved combinational frequency shifts.



Above, RAMAN SPECTRUM OF DIAMOND; below, MERCURY SPECTRUM.

R. S. KRISHNAN.
Physics Department,
Indian Institute of Science,
Bangalore. Dec. 12.

[1] Raman, C V., *Proc Ind Acad Sci*, A, **18**, 237 (1943).
[2] Bhagavantam, S, *Proc Ind. Acad Sci*, A, **18**, 251 (1943).
[3] Chelam, E V, *Proc Ind. Acad. Sci*, A, **18**, 334 (1943)
[4] Krishnan, R S, *Proc Ind. Acad Sci*, A, **19**, 216 (1944)

Shear Modes in Piezo-electric Crystal Plates

WHILE investigating the diffraction patterns produced by ultrasonic waves set up in a liquid medium by piezo-electric crystal plates, we made the following observations. Besides the usual thickness longitudinal mode, diffraction patterns corresponding to thickness transverse or shear modes have been observed occasionally. We find that the appearance of such patterns is facilitated when the crystal plates are either silvered in patches only, or so prepared that there is a deviation from the normal cut. When irregular silvering is adopted, not only do the odd harmonics of the shear modes make their appearance, but also the even harmonics of all the modes begin to show up. Such results have been observed by us in differently oriented plates of quartz and tourmaline and used for determining the elastic constants corresponding to the shear modes of these crystals. Details of these investigations are being published elsewhere.

These observations mean that particular shear modes cause longitudinal strains in the crystal plates resulting in corresponding longitudinal ultrasonic waves in the liquid. The phenomenon is presumably connected with the coupling between the longitudinal and shear modes produced either by the finite size of the plate or the cut of the plate, being such that the modes themselves are inherently coupled.

S. BHAGAVANTAM.
D. SURYANARAYANA.
Department of Physics,
Andhra University. Dec. 18.

Significance of Power-Law Relations in Rheology

IN studying the relationship between shear stress (S), strain (σ) and time (t) in the deformations of certain bodies showing complex properties, many rheologists have effectively used Nutting's equation[1], which is now usually written

$$\psi = S^{\beta}\sigma^{-1}t^{k} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

From the point of view of physics, this has been regarded as an empirical equation and its meaning has been difficult to envisage. Exponential equations can be pictured in terms of dash-pots and springs, but power-laws lead to no such simple models.

We would suggest that a helpful way of viewing the matter, at any rate for the most usual type of experiment in which the test-piece is strained at constant stress, lies in the relationship between power-laws and fractional differentials.

Scott Blair and Coppen[2], acknowledging the help

of Dr. P. White, have discussed the significance of a fractionally differentiated form of the Nutting equation in connexion with psycho-physical experiments, and write

$$\frac{\partial^n \sigma}{\partial t^n} = \frac{\Gamma(k+1)}{\Gamma(k-n+1)} \cdot t^{k-n}\, \psi^{-1} S, \quad . \quad . \quad . \quad . \quad (2)$$

where $0 < n < 1$, and $\beta = 1$. This equation has also been noted by Whitehead[3] to be the differential equation with fractional coefficients which represents a power-law.

Scott Blair[3] has proposed, as an alternative to the Nutting treatment, that complex materials be considered to show a property intermediate between shear modulus and viscosity which is, like them, independent of stress, and defined as follows:

$$\chi = S \div \frac{\partial^m \sigma}{\partial t^m} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

We had not hitherto realized, however, that if the same exponent is used throughout in the above equations, so that $k = n = m$, equations (2) and (3) become identical, since $\frac{\Gamma(k+1)}{\Gamma(1)}$ is a pure number. Since the property χ would seem to be more easily envisaged than are the Nutting constants, the identity of equations (2) and (3) clarifies our understanding of the rheological behaviour of complex bodies. At constant stress, $\partial^k\sigma/\partial t^k$ is constant; k being, as usual, zero for Hookean solids and unity for Newtonian fluids. The physical and psycho-physical significance of k has already been widely studied[4].

Where $\beta \neq 0$ and S is not constant, another fractional differentiation is, of course, required; though the treatment here is not so fully understood, nor perhaps so soundly based, as that for k. We are indebted to Dr. S. Whitehead for directing our attention to the fact that the treatment here proposed must be regarded in a sense as limiting equation (1). We had already appreciated[5] that equation (1) is only applicable in its integral form under specified conditions of stress and strain, and we are at present engaged in investigating its limitations experimentally.

Nutting's equation implies that for constant stress, for example, the rate of deformation at any time is proportional to the average rate from the start of the experiment up to that time; and further, the strain and time described as zero are arbitrary, since strain is now taken to include non-recoverable deformations and any figure may be defined as zero strain.

For materials for which $f(S,\sigma,t)$ is dependent on the history of the experiment, a direct plot of strain or time would therefore be misleading, since it would wrongly imply that a change of zero could be made in strain or time without altering $f(S,\sigma,t)$. The log-log plot does not suffer from this defect.

Maxwell[6] appears to have foreseen something of this when he suggested that relaxation times of complex materials might well be a function of stress.

J. E. Caffyn.
G. W. Scott Blair.
National Institute for Research in Dairying,
Shinfield, Nr. Reading. Nov. 21.

1 Nutting, P. G, *J. Amer Soc Testing Mats.*, **21**, 1162 (1921), *J Franklin Inst.*, **191**, 679 (1921).
2 Scott Blair, G. W, and Coppen, F. M. V., *Amer J. Psychol*, **56**, 234 (1943).
3 Electrical Research Association, June 1944.
4 Scott Blair, G. W., *J. Sci. Instr.*, **21**, 80 (1944) (in which a bibliography of papers on the use of Nutting's equation is included).
5 Scott Blair, G. W., and Caffyn, J. E., *J. Sci. Instr*, **19**, 90 (1942).
6 Maxwell, J. C, *Phil Mag*, **35**, 129 (1868).

Freezing Point of Artificially Induced Bovine Mammary Secretions

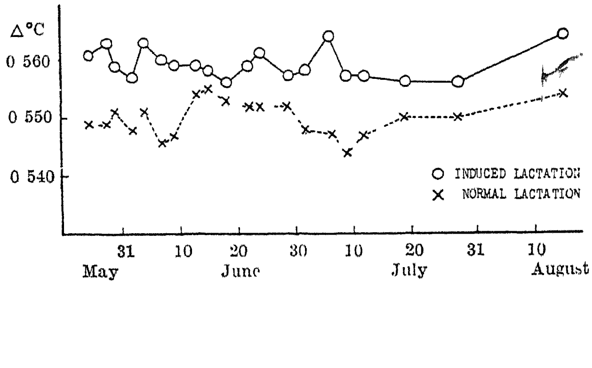
It is well known that the freezing point depression of milk is remarkably constant for cows in normal lactation[1] Folley and Malpress[2] have described experiments in which maiden Shorthorn heifers were treated by implantation of diethylstilbœstrol and hexœstrol, and they were good enough to supply me with samples of secretions from one animal in the former and two in the latter experiment. Three control animals from the same herd were also tested Lactation in the three virgin heifers was initiated on May 21, 1942, following the administration of hormones on May 11, 1942. One heifer received, during the treatment, 2·40 gm. of diethylstilbœstrol, the second and third, 5·01 gm. and 2·54 gm. of hexœstrol tablets. The heifers were milked once a day until they yielded 5 lb. of milk, when they were milked twice a day. The maximum daily yield was 22 lb. from one heifer and 17 lb and 14 lb. from the others.

For the determination of freezing-point depression, an improved model of the apparatus described by Temple[3] was used which provides results in very close agreement with the Hortvet[4] method. Following Elsdon and Stubbs'[5] suggestion, the thermometers, which were of the Hortvet type, were standardized by using three sucrose solutions. All samples were taken from individual animals and refrigerated soon after milking. Morning and evening milk was collected separately and tested within 18 hours of milking, mostly within a much shorter period. The freezing point depressions of 119 morning and 103 evening samples were determined; 59 morning and 46 evening samples being from the treated animals.

The average freezing-point depressions for each date are plotted in the accompanying graph. From this it will be seen that all the results indicate a persistently higher freezing-point depression for the secretions from the treated animals. The general mean for the maiden animals is 0·559° C., compared with the 0·550° C. for that of the other cows, and this difference is highly significant. Separate evaluation of freezing-point depressions for morning and evening samples also showed significant differences. The average values were, for normal secretions, morning 0·547° C., evening 0·553° C.; and for induced lactation, morning 0·558° C, evening 0·560° C.

For their normal cows, Aschaffenburg and Veinoglou[6] have shown that during the summer the freezing-point depression is persistently higher for evening than for morning milk, whereas in winter the reverse is true. Induced secretions were examined only during the summer, but likewise showed significantly higher freezing-point depressions for evening samples.

There were differences in the age and parity of the animals from which these samples were taken,



but Aschaffenburg and Veinoglou[6] and many others have shown that there is no correlation between these factors and the freezing-point depression of the milk.

Summarizing, it appears that, although only three treated and three control animals were studied, the persistently high freezing-point depression for the former constitutes a sufficiently unusual phenomenon to justify the hope that more extended experiments will be undertaken.

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Accuracy of Mineral Frequency Analysis of Sediments

IN view of the important paper by Rittenhouse and Bertholf[1] on the relative efficiency of gravity and centrifuge separation as applied to sedimentary analysis, it seems desirable to present the results of certain critical examinations of sedimentary technique carried out by us during the last five years. Though originally begun merely with the intention of assessing the relative merits of certain grain-counting methods (preliminary to the computation of mineral frequencies), our work has led us to a wider study of several of the sources of error likely to operate during laboratory treatment of sediments.

Basically, our method consists of applying the various 'treatments' (for example, counting methods, washing, boiling in hydrochloric acid), and certain combinations of them, to series of replicate random analyses made from thoroughly mixed ('homogenized'[2]) sediment. Statistical manipulation of the resulting data by analysis of variance in the ordinary way then permits recognition and partition of the treatment effects. Only gravity separation (in bromoform, by Milner's method[3]) has so far been employed. Throughout, the specific and varietal frequencies have been expressed as number-percentages.

We utilize two counting methods. In both, the minimum acceptable number of allogenic grains per 'light' or 'heavy' subsample count is fixed at 1,000—for obvious statistical reasons. Purely authigenic mineral species are not counted. This also applies to the micas, chlorites and similar flaky minerals having densities close to the borderline between 'heavy' and 'light' (s.g. 2·9), for their errors of separation are found to be unsystematic, unpredictable and disproportionately large. In the first method (P.S.W.), central transects (totalling 1,000 allogenic grains or more) are counted across each of the several slides ('heavy' or 'light') made from gravity separation in bulk. In the second (P.A.), '1,000-grain' subsamples representing complete separations are counted entirely. Each method has been utilized in making replicate series of number-percentage determinations (at least five per series) from certain coarse-, medium- and fine-grained sediments.

On testing the frequencies in each replicate series for homogeneity[2] with χ^2, we obtained no evidence leading us to suspect that the fluctuations of specific and varietal frequency within *the coarse-grained and medium-grained sediments* were usually due to any factor other than random sampling ($P > 0·05$ in most cases). The sensitive additive χ^2 test (ref. 4, p. 79) showed that this was also probably true of each 'coarse' replicate series as a whole ($P > 0·05$ in most cases). On the other hand, when applied to

Allogenic heavy mineral species	Coarse-grained* Weighted arith mean %	k_s†	χ^2	P lies between	Medium-grained** Weighted arith mean %	k_s†	χ^2	P lies between
Black Iron Ore +Leucoxene	53·82	1·2	6·039	0·20 and 0·10	40·99	1·5	9·039	0·10 and 0·05
Zircon	25·24	1·0	4·355	0·50 and 0·30	15·70	2·2	19·709	<0·01
Tourmaline	7·20	1·2	5·748	0·30 and 0·20	17·69	2·6	26·885	<0·01
Rutile	6·46	0·9	3·025	0·70 and 0·50	10·74	2·1	16·959	<0·01
Kyanite	3·58	1·2	5·574	0·30 and 0·20	1·67	1·2	6·077	0·20 and 0·10
Staurolite	2·44	1·1	4·870	0·50 and 0·30	1·80	1·3	6·292	0·20 and 0·10
Sillimanite	0·62	0·6	1·677	0·80 and 0·70	0·31	0·9	3·379	0·50 and 0·30
Sphene	}				0·45	1·4	8·191	0·10 and 0·05
Monazite	}							
Garnet	}				3·55	1·5	9·464	0·10 and 0·05
Epidote	} 0·64††	1·1	4·438	0·50 and 0·30	3·49	3·8	56·817	<0·01
Brookite	}				0·55	1·4	7·714	0·20 and 0·10
Anatase	}				0·34	0·7	1·809	0·80 and 0·70
Andalusite	}				}			
Topaz					}			
Glaucophane					} 0·19††	1·2	6·035	0·20 and 0·10
Corundum					}			
Zoisite					2·52	1·6	9·902	<0·05
$\sqrt{2(\Sigma\chi^2)} - \sqrt{2\Sigma(c-1)-1}$	= + 0·52, giving P between 0·61 and 0·60				= + 8·87, giving $P < 10^{-9}$			
	First counting method.				First counting method			

* Coarse sand from Bagshot Sand (Eocene), Longlands W pit, 1 m. E S E. Brading station, I.o.W.
** Medium-grained sand from base of Upper Headon Beds (Oligocene), Headon Hill, I.o.W.
†k_s = the ratio total standard error/standard error of random sampling[2].
†† Pooled, because expected numbers of grains in sub-samples were less than 5 (ref 4, pp. 22 and 82).

Our thanks are due to Dr. J C. P. Miller for his time-saving observation that, when k is calculated from weighted frequencies, and c is the number of analyses per replicate series, $\chi^2 = (c-1)k^2$.

the *fine-grained sediments*, the tests led us to conclude that the variations were *not* usually attributable to random sampling alone ($P < 0 \cdot 05$ for the majority of species, varieties, and replicate series). Some results for the heavy mineral suites from two of the three main sedimentary grades examined are summarized in the accompanying table. Varietal analyses have been omitted for reasons of space.

Systematic errors (investigated by analysis of variance) were found to be serious only for certain flaky minerals in the fine-grained sediments. No practical justification was obtained for the theoretical criticisms frequently levelled at the transect (and 'random field') method of counting. It is clear that, providing the specific and varietal size-differences are not excessive (a condition hydrodynamically assured for the allogenic suites of most sediments), their adverse influences upon frequency estimations obtained by the transect method are not sufficiently great to warrant consideration.

The main conclusions arising from our work may be summarized as follows: For most allogenic minerals but certain flaky species (micas, chlorites, etc.) within coarse- and medium-grained sediments, the errors of number-frequency due to normal laboratory treatment are sufficiently small to be neglected, providing that the container of the separating apparatus is large enough for adequate dispersal of the grains. For fine-grained sediments, the laboratory errors are liable to be considerable for all allogenic species. A method for estimating and manipulating the latter has been given before[2].

We are thus able to offer independent confirmation of certain of the results obtained by Rittenhouse and Bertholf.

Transect errors are mainly of theoretical interest, and will be dealt with elsewhere.

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Transmission by Insects of a Plant Virus Complex

STUDIES on the rosette disease of tobacco, first recorded by Wickens[1], have shown that the disease is a complex one consisting of two undescribed viruses for which the names 'vein-distorting' and 'mottle' viruses respectively have been suggested[2]. The vein-distorting virus cannot be transmitted mechanically but is dependent upon an aphis vector; whereas the mottle virus is easily transmitted by sap-inoculation. Investigation of the insect-relationships of these two viruses[3] has revealed some interesting facts. All attempts to transmit the mottle virus by aphis vectors have failed, *unless it is accompanied in the plant by the vein-distorting virus*.

The following description of one experiment out of many will make this clear. A tobacco plant, var. White Burley, infected with the mottle virus, was colonized with the aphis *Myzus persicœ* Sulz.; after the requisite feeding period the aphides were removed and colonized on twelve young tobacco seedlings, 5–10 aphides per plant. All twelve plants remained healthy. The mottled tobacco plant, from which these negative attempts at transmission were made, was then infected by means of aphides with the second component, the vein-distorting virus. In due course the plant developed the rosette virus complex. This plant was then again colonized with virus-free aphides and, after the requisite feeding period, these aphides were transferred to twelve tobacco seedlings, but using only one aphis per seedling as compared with 5–10 in the previous experiment. Nine out of the twelve seedlings developed the rosette disease, which of course contains the mottle virus as one of its components. Having once picked up the mottle virus together with the vein-distorting virus, the aphis retains them both for long periods and in successive transfers at twenty-four hour intervals can infect twenty consecutive plants without recourse to a fresh source of virus. Having once become infected with the virus complex the aphis, in a series of transfers, sometimes transmits the mottle virus alone, sometimes the vein-distorting virus alone and sometimes the whole complex. A somewhat similar phenomenon has been recorded in the aphis transmission of two potato viruses[4], but a clear-cut obligate relationship such as this between two viruses so unlike as the components of the rosette complex seems to be of unusual interest.

The most likely explanation of the phenomenon is a quantitative one; namely, that there is more mottle virus in a plant infected with the complex disease than in a plant containing this virus alone. But dilution tests made from the complex and from the mottle virus respectively do not appear to support this explanation.

It is possible that this phenomenon has a wider application in Nature than has been realized, and it may be discovered that other plant viruses which are apparently not insect-borne when alone can be so transmitted when in the presence of another virus.

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Selective Power in Virus Transmission Exhibited by an Aphis

THE selective power exhibited by insects in their transmission of different plant viruses is a subject of considerable interest since it is calculated to throw some light on the relationship between virus and insect. Such selective transmission has been studied by Hoggan[1], Kenneth Smith[2] and Kassanis[3], while Black[4] has shown that there are two strains of potato yellow dwarf virus, each with its specific insect vector.

So far as I am aware, however, the selection of one virus by a particular aphis species, out of a complex of two closely similar aphis- and sap-transmissible viruses, is a new phenomenon. This has been demonstrated in my experiments on the aphis-transmission of viruses affecting cruciferous plants.

The viruses in question were those of cabbage black ringspot (*Brassica Virus* 1) and cauliflower mosaic (*Brassica Virus* 3).

The aphides *Myzus persicæ* Sulz. and *Brevicoryne brassicæ* Linn., when colonized on cauliflower seedlings infected with these two viruses, transmit both, but the aphis *Myzus ornatus* Laing, similarly colonized, picks out the cauliflower mosaic virus, leaving the black ringspot virus behind.

A full account of this work is being published elsewhere.

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Fluorine in Fish Pastes

THOUGH there is much interest at the moment in the fluorine constituent of the diet, appreciation of the benefits to be obtained from certain types of food which have recently been shown to contain fluorine is by no means new. For example, in ancient Tibet the most cherished gifts received by a new mother consisted of powdered yak bone and pigs' knuckles. In India a diet of rice and fish, from which the bones were discarded, commonly resulted in calcium deficiency, which was remedied when small whole fish were included in the diet. In Deaf Smith Country, Texas, where the fluorine content of the water is 2·2–2·7 parts per million, the inhabitants are reputed to have a very low dental caries susceptibility. In a recent investigation on the Tyneside, it has been suggested that the delayed onset of caries in a section of the population may be due to the fact that the water supply to this particular area contains 1·4 parts of fluorine per million. The Eskimos of the Pacific northwest have superb teeth and their diet includes soft fish bones which contain 250 parts per million of fluorine.

Before the War, some fish-paste manufacturers obtained their supplies from fresh fish, others from canned fish; there is reason to believe that some manufacturers now use macerated whole fish in the mix, and it was therefore thought that fish pastes might contain much available fluorine. We recently requested the Chemistry Division of the Royal Aircraft Establishment to analyse five well-known brands of fish paste; the following report was received:

Type of paste	Calcium % Ca/wt.	Phosphorus % PO_4/wt.	Fluorine parts/million (wt.)
1. Bloater	0·17	0·39	5·8
2. Salmon, shrimp, etc.	0·22	0·43	8·2
3. Smoked herring ..	0·12	0·25	3·1
4. Salmon and shrimp .	0·23	0·37	8·0
5. Salmon and shrimp..	0·26	0·34	8·9

"The method employed consisted of ashing the paste at dull red heat (600° C.), followed by extraction of the ash with dilute hydrochloric acid. Calcium was determined by precipitation as oxalate followed by back-titration with standard hydrochloric acid. Phosphorus was estimated by precipitation as magnesium ammonium phosphate which was then ignited to magnesium pyrophosphate. Fluorine was determined in accordance with the method described in the *Analyst* of August 1944, page 243: (Steam distillation of the ashed paste with perchloric acid in the presence of silicates and subsequent comparison of the distillate with a standard fluoride solution, using an Alizarin Red/Thorium lake as the colour indication)."

It has been suggested that the diet should contain 1 milligram of fluorine per day for the prevention of caries; this is provided by 2½ quarts of milk, or three grams of beef bone, or a quarter of a pound of fish paste (types 4 or 5).

We feel, then, that there are probably few people who would go to the extreme of taking daily 1½ jars of fish paste in the hope of avoiding the necessity of conservative dental treatment, and suggest that they seek a more suitable source of fluorine.

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Effect of Methionine upon Nitrogen Losses in the Urine following Severe Burns

IT has been known for some time that, following fractures, there are losses of nitrogen in the urine as urea[1]. Lately, in this laboratory, similar losses have been found after severe burns in animals, the loss being quite appreciable even ten days after burning[2]; these changes also occur in patients[3]. The nitrogen loss in rats can be largely eliminated by increase of protein in the diet from 14 to 22 per cent[4]; this figure including some 4 per cent of yeast protein[4], the remainder being casein. In man it has proved necessary in some patients to give up to 2,000 gm. of protein per week to stem the nitrogen loss[3].

In attempting to explain this loss, one hypothesis to be considered is that the tissue proteins are being raided by the body to provide one, or perhaps a few, amino-acids especially needed for repair of the burned area; the increased nitrogen elimination would then be due to the excretion as urea of nitrogen from the unwanted amino-acids in the raided protein molecules. We have obtained evidence in support of this hypothesis. In controlled experiments with rats, 1 per cent *dl*-methionine prevented the loss after burns as effectively as the increased protein in the experiments referred to above. This improvement was not obtained with alanine or with an *ad hoc* amino-acid mixture.

These facts, supporting the hypothesis advanced, at the same time make unnecessary the view that the nitrogen losses in burns are due to toxæmia, as they can be explained upon the basis of deficiency. Now that tannic acid has been discontinued, due to the finding that it may damage the liver in human patients[5] as well as in animals[6], there is little evidence that thermal burns *per se* cause liver damage[7]; hence it does not seem that the effect obtained with the methionine is due to its well-known action upon the fat metabolism[8]. The reason for the call for methionine is not yet clear, nor the physiological steps involved; but the experiments, the full details of which will be presented elsewhere, suggest

that methionine might benefit patients suffering from burns, at the stage where the appetite is too poor to allow of ingestion of adequate protein. An amount of 5 gm per diem has been tolerated[9].

Our thanks are due to the Medical Research Council for grants in aid of this research and to the Ministry of Supply for synthetic methionine and other amino-acids which made the work possible; to J. Jenkins for technical assistance and to colleagues in the Department for advice. The work has been carried out under the ægis of the Burns Sub-Committee of the War Wounds Committee, Medical Research Council.

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Colour Phenomena in Ultra-Violet Vision

THE note by N. I. Pinegin[1] suggests a more detailed discussion of the relation between the threshold intensities for scotopic and photopic vision in the ultra-violet. The threshold ratio T_p/T_s is a measure of the intensity range, often misleadingly called 'photochromatic interval', in which the visual impression is free from the specific colour sensation. This intensity range is a marked function of the position of the illuminated area on the retina, the threshold ratio increasing with increasing angle from the fovea. Since Pinegin's note does not contain any data for this angle, it is difficult to draw definite conclusions from his results.

It seems, therefore, a suitable opportunity to record the results of measurements of the threshold ratio at 365 mμ for four normal observers and one observer with an aphakic eye. These measurements were made in 1938 in connexion with investigations on the photosensitivity of visual purple and scotopic vision in the ultra-violet[2]. The threshold ratio was determined using the same observers and apparatus as described in the previous paper for the measurement of the absolute scotopic sensitivity at 365 mμ. The procedure adopted was as follows:

After 5 minutes dark adaptation, monochromatic light flashes of about 1 second duration were viewed with the parafoveal region of the retina 10° temporal or nasal for right or left eye of the observer respectively. (The illuminated retinal area was a circular patch subtending an angle of 2·6° in the normal eyes and 4·4° in the aphakic eye.) The intensity of the flashes was twice slowly decreased and increased, and the relative intensities noted which corresponded to the disappearance and reappearance of the 'colourless' (scotopic) visual sensation and the colour (photopic) sensation. This procedure occupied 8–11 minutes The mean values for the threshold ratio arrived at from the observations and shown in the table correspond, therefore, to a mean dark adaptation of 9–10·5 minutes. Little variation of T_p/T_s with dark adaptation was found after the first 5 minutes.

Observer	Age	Eye	$\log_{10} (T_p/T_s)$
G C	27	R	1·8
C F G.	34	R	2·3
R J L	42	L	2·3
E E S	27	L	2·1
A G G	26	L *aphakic*	I 2·7 II 4·7

Assuming that Pinegin's results for the absolute photopic threshold were obtained in a comparable retinal region, we get in conjunction with the results from our earlier paper for the absolute scotopic sensitivity a value $\log_{10} T_p/T_s = 2\cdot6$ at 365 mμ, in fair agreement with the above table. A value of $\log_{10} T_p/T_s = 2\cdot7$ at 546 mμ derived from the same sources could be compared with the measurements of Wentworth[3] which gave values of $\log_{10} T_p/T_s = 1\cdot8$ and 2·2 at 522 and 582 mμ respectively and at a retinal position of 10° from the fovea.

The most remarkable result of our measurements is the appearance of a clearly defined second chromatic threshold in the aphakic eye. An increase of the light intensity in the region of violet sensation above the first threshold led to a point where there is a sharp transition from violet to a distinctively blue sensation. Furthermore, this transition point could be reproduced quite accurately irrespective of whether it was approached from above or below. The value of two logarithmic units derived from the table above represents, therefore, a definite quantitative measure for the intensity interval between the blue-violet point and the violet-colourless point. It seems likely that this effect is a consequence of the extremely high sensitivity of the aphakic eye in the ultra-violet, where it is found to be of the same order as in the visible part of the spectrum. The sensitivity of normal eyes was found to be about 10,000 times smaller at 365 mμ than at 546 mμ. As this difference is due to the presence in normal eyes of an absorbing substance in front of the perceptive organs of the retina rather than to a difference of the process of vision in the two spectral regions, it is to be assumed that the complex colour vision is also present in normal eyes but not clearly observable at usually available light intensities. An indication of its presence in normal eyes may be found in the widely diverging descriptions of the subjective colour of ultra-violet light, ranging from distinctive blue to distinctive violet[4], and in the frequent observation of Goodeve (private communication) that a strong mercury arc viewed through a deep violet filter which passes only the 405 mμ line, looked quite blue.

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Colour Vision of the Fovea Centralis

MR. E N WILLMER[1] in his communication in *Nature* of May 11, 1944, and in his recent address to the Colour Group of the Physical Society (November 22), directed attention to the defective colour vision of the fovea centralis in the normal eye. He pointed out that the colour confusions which occur there are similar to those experienced by blue-blinds (tritanopes)

It is worth recalling that fifty years ago Konig[2] came to a like conclusion from careful experiments on his own and other normal eyes. Describing his work, he wrote "I have established the complete dichromatism of my fovea by setting up foveal colour matches between mixtures of 650 mμ and 475 mμ on the one hand and all intermediate spectral regions on the other. The matching field could, it is true, be held in the fovea for only a few seconds, frequently for only a fraction of a second". Despite these fixation difficulties, Konig was able to determine the green and red *Elementarempfindungen* for the central fovea, and to compare them with the corresponding curves for a larger matching field extending into the truly trichromatic region of the macular retina. He explained the observations in terms of his theory of the function of visual purple and visual yellow. The theory has not thrived and the experimental result just described may in consequence have attracted less attention than it deserves. Parsons[3] refers to it, however.

It may be well to emphasize that partial or complete blue-blindness of the fovea centralis can be accommodated in various visual theories (Konig's own, for example) and does not provide a crucial test of Mr. Willmer's.

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DR. M. H. PIRENNE's experiment on colour vision[1] seems to be designed to test Willmer's suggestion that the rods are the end organs which are mainly responsible for the sensations of blue and violet[2], and he reaches the conclusion that "The rods are not necessary for colour vision".

Such a conclusion from this experiment (much of the substance of which is reported by Parsons and attributed to Gotch[3]) is scarcely justified. Pirenne's curve for violet light shows three 'coloured' points, two of which, those at 0·75° and at 0·34°, would, on the basis of Østerberg's data, fall on rod-containing retina. The third, if accurately focused, seems to utilize a portion of retina free from rods, but when astigmatic and other aberrations are considered, even this test area might fall partly on the rods. Thus the 10′ test field used could have stimulated the rods; and therefore if one postulates, as Willmer has done, that the rods are mainly concerned in blue and violet vision, the results given are not contradictory to this suggestion.

Objects which subtend a much smaller visual angle than 10′ would seem to be necessary if evidence is to be collected on this point. One such object is used in the following experiment, which demonstrates the blue blindness of the fovea noticed by Konig (ref. 3, p 84). A hole 2 mm in diameter was drilled in sheet metal and covered with an Ilford spectrum-violet filter which is stated to transmit only wavelengths less than 4800 A. This was then viewed at a distance of 10 metres with a strong source of illumination behind it. By looking directly at the violet spot and so using foveal vision, the small star-like image could be made to disappear entirely; whereas on viewing the test object with the parafoveal retina the deep violet colour could be easily seen. If the Ilford spectrum-red filter was used (stated to pass only wave-lengths greater than 6200 A.), no such disappearance with foveal and reappearance with parafoveal vision was possible at any distance The test object subtends an angle of about 1′ at the eye in this experiment, but owing to aberrations of the optical system the area of the retina illuminated in practice would be larger than that calculated from this visual angle; it is probably not larger than the size of the rod-free area given by Østerberg.

The blue blindness of foveal vision can be explained in two ways:

1. The test object disappears because its image lies wholly within the rod-free area of the retina, and thus according to Willmer's theory on receptors which are insensitive to violet light.

2 At the fovea there is an increase in the amount of macular pigmentation sufficient to absorb the whole of the violet light.

This latter view is commonly held; but it does not agree with anatomical data, which show that the amount of yellow macular pigment present is actually less at the fovea than it is at other parts of the central area, and it may possibly be absent altogether[4]. The absence of violet receptors in this region would explain the above result quite as well.

It might be argued that if indeed there was a violet-blind foveal area, one would see a dark spot at the centre of an evenly illuminated violet field. In fact, one would not see such an area, because one would disregard it in the same way that one disregards the shadows on the retina of the retinal vessels. Hence it appears that the rods may be necessary for colour vision and may be, as Willmer postulates, the receptors most concerned with violet vision.

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[1] Pirenne, M H , *Nature*, **154**, 741 (1944)
[2] Willmer, E N , *Nature*, **151**, 213 and 632 (1943)
[3] Parsons, J H , "Colour Vision", 2nd ed., 85 (Cambridge, 1924)
[4] Polyak, "The Retina", 198 (Chicago, 1941)

MR. L. C. THOMSON says in his communication that my experiments[1] on colour vision in the dark-adapted eye do not prove that the rods are not necessary for colour vision, because in all cases the blue light of the test field might (according to Mr. Thomson) have stimulated rods—which in Willmer's[2] theory are supposed to be mainly responsible for blue and violet vision. It must first be pointed out that my statement "The rods are not necessary for colour vision" is not a general conclusion, as it may appear to be in the quotation given by Thomson. Its context

shows that it refers to the particular conditions of the experiments. It continues: "on the contrary, where they [the rods] are present in fair numbers, the colour of the violet test field vanishes"[1]. This fact is not explained, or even mentioned, by Thomson. It was, however, the crux of the argument.

It is by no means certain that, as suggested by Thomson, the rods were always stimulated to some extent in the experiments mentioned. As can easily be verified, the use of a 2 mm. artificial pupil reduces in a striking way the effects of aberrations of the eye in what concerns the spread of the retinal image. Since the experiments were made at threshold intensities, moreover, it is likely that only the brighter, central part of the retinal image of the field was actually able to stimulate receptors. The field, when seen, appeared as a well-defined small area. All this makes it improbable that rods were stimulated when the field was presented at an angle of 0·15°. (When the light falls in an area containing a certain number of rods, as presumably happens at an angle of 0·75°, the cone threshold may still be lower than the rod threshold if the field is small and if spatial summation in the rods takes place only to a small extent.)

Even if it were proved, however, that the rods were always stimulated in the experiments discussed here (using the dark-adapted eye), the fact remains that the presence of many rods, as observed in parafoveal vision, is highly *detrimental* to blue or violet vision. In brief, therefore, when an area containing many rods is stimulated with violet light, no colour is seen; and, in some of the cases where colour is seen, it is at least doubtful whether any rods are stimulated. These observations seem incompatible with Thomson's suggestion that the reason why (in my experiments) the light appeared coloured by foveal vision is that it spread on to parts of the retina which contain rods. (The mechanisms active under conditions other than dark adaptation are not discussed either in the original paper or here.)

The bibliography given in my paper makes it clear that there was no claim to originality in the type of experiments described. They were made largely because Wentworth[3] in her extensive investigation (which is more recent than Gotch's[4] and more like my experiments) had found in the central area of the retina an achromatic threshold which is lower than the chromatic threshold. This was not found in my experiments. Differences in the conditions used account in a general way for the different results obtained.

Thomson reports an experiment from which he seems to conclude that the rod-free area is completely insensitive to violet light, and which he gives as a demonstration of the 'blue blindness' of the fovea noticed by König[5]. What Konig meant by this 'blue blindness' is a certain type of dichromatism "which, however", in Konig's words[6], "by no means implies complete insensitivity to light of short wave-length". This is obvious, for König states[7] that he was able to match all spectral colours with mixtures of 650 mμ and 475 mμ in the fovea, which implies that the latter wave-length is able to stimulate the fovea—and that the stimulation it produces can be confined to the receptors contained in this area. It is therefore possible that, if the violet light used by Thomson was not seen by foveal vision, it was because the light was not sufficiently bright.

According to König's data, the centre of the fovea is dichromatic. According to Young's theory, it is therefore a two-receptor system. But it is not clear whether the more peripheral parts of the rod-free area, in which the cones are somewhat different anatomically from those of the "bouquet central"[8], are dichromatic or trichromatic. It seems that the discussion cannot be carried much further before this point is settled.

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Jan. 25.

[1] Pirenne, M. H., *Nature*, **154**, 741 (1944).
[2] Willmer, E. N., *Nature*, **151**, 213 and 632 (1943); **153**, 774 (1944).
[3] Wentworth, H. A., *Psychological Monographs*, **40** (1930).
[4] Gotch (1912) quoted in Parsons, Sir J. H., "An Introduction to the Study of Colour Vision" (Cambridge, 2nd ed., 1924).
[5] Konig, A., "Gesammelte Abhandlungen zur Physiologischen Optik" (Leipzig, 1903).
[6] Konig, A., *loc. cit.* 396.
[7] Konig, A., *loc. cit.* 356.
[8] Østerberg, G., *Acta Ophtalm.*, Suppl. 6 (1935).

Persistence of Vision

PERSISTENCE of vision is the basis of the cinematograph, but there is no persistence of vision when the eye is moved in ordinary circumstances. If there were, reading would be a difficult and slow process. This is explained by the double function of the ocular muscles, the decomposed photochemical products being pressed in the direction in which the eye moves, beyond the fixation point.

There is another form of persistence of vision, namely, that of positive after-images. If a strip of white paper 3 in. × ½ in. be placed on a sheet of black cardboard, in a good light, and viewed for the shortest possible time, and the eyes then closed and covered with the hands, a clear-cut positive after-image of the paper will be seen, which will gradually fade away without becoming negative. If the eyes, being closed and the positive after-image clearly visible, are moved to the right, the whole after-image will appear to move to the right, past the fixation point. It will also bulge towards the right. These observations can be explained on the view that the photochemical stimulus in vision is in liquid form, and that the cones are stimulated indirectly by these products, and not by the direct action of light.

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Classification and Nomenclature of Animal Behaviour

MODERN work on the simpler forms of behaviour has gained much from the classification of reactions into different types. Its main achievement has been the separation of kineses from taxes. Fraenkel and Gunn have brought order into the subject with their book, "The Orientation of Animals: Kineses, Taxes and Compass Reactions" (1940). The following criticism is offered in the belief that they have provided a valuable point of departure for future work.

The authors argue (p. 22) that "When activity results from high intensity or concentration of the stimulus, it should be called *high kinesis*, and when it results from low intensity or concentration, it should be called *low kinesis*". There is a weakness

here that the authors do not deny If a kinesis is called 'high', the obvious implication is that it is a stronger reaction than one that is 'low'. It requires a mental effort to recall that 'high' is used quite differently here, to indicate the *sense* or '*sign*' of the reaction with reference to the stimulus. The authors fear that even greater confusion would arise if high kinesis were called positive kinesis A positive photo-kinesis, for example, can lead to aggregation in darkness, but this has been called photo-negative behaviour in the past. The argument raises a wider issue than mere nomenclature.

Besides clearing up confusion among reactions, recent work has helped to clear up another source of past confusion. It has sharpened the distinction between the two planes on which behaviour may be studied. On one plane are the reactions of single animals to single stimuli, the *units* of behaviour. On a higher plane are the spatial re-distributions and average activity changes that appear when a mass of animals is subjected to a whole system of stimuli It follows that the laws governing the units of behaviour must underlie, but cannot be the same as, the laws governing organized systems of those units.

Fraenkel and Gunn do not make that qualitative distinction. For example, they describe aggregation in temperature gradients and average activity changes under continuously changing temperature. They show how such behaviour has been misinterpreted in the past by treating it as equivalent to simple reactions or metabolic effects. Having gone so far, they return to the analysis of reactions, as if mass behaviour comprised no more than a sum of reactions. They do not emphasize that mass behaviour has its own laws requiring separate study. Instead, they argue that a term like 'photo-negative' should be applicable to kineses, taxes and aggregations alike. This confuses different reactions; and more, it confuses phenomena on two different planes.

The following usage is suggested as more logical. Terms like 'photo-negative' should be confined to the description of taxes. This removes any justification for the awkward expression 'high kinesis'. The sense or 'sign' of reactions should be indicated uniformly, using positive and negative for both kineses and taxes. Thus, in the case of a positive kinesis, strengthening the stimulus leads to greater activity, and weakening it leads to weaker activity. In a gradient of stimulation intensity, aggregation would occur where the stimulus was *weakest*. In the case of a positive taxis, of course, aggregation occurs where the stimulus is strongest. In a negative kinesis, strengthening the stimulus leads to weaker activity, and weakening it to greater activity. In a gradient, aggregation will be where the stimulus is *strongest*. In a negative taxis, aggregation occurs where the stimulus is weakest. This usage should serve to sharpen the distinctions drawn above and so help to consolidate the gains of recent years.

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WHEN writing the book referred to by Dr. Kennedy, we were frequently faced with the alternatives of inventing new technical terms (which are often resented by the people who have to learn and use them) and of using common words in newly defined ways (which causes trouble because it is difficult to exclude from one's mind some of the common implications of the words). If Dr. Kennedy, who has studied insect activity and aggregation in the field as much as anyone, has to make an excessive mental effort with 'low' and 'high' kinesis, then the generality of zoologists must find them very troublesome indeed. The advantage of the broad use of 'photo-negative' is that it can be applied to a particular reaction before one knows which type of behaviour is responsible for aggregation in the dark. 'Positive' photo-kinesis can lead to photo-negative behaviour. If this awkwardness of signs is generally thought to be preferable to the ambiguity to which Dr Kennedy directs attention, then let us use his modification of the system of terms

Dr. Fraenkel and I did not write much about the plane of integrated behaviour, because we set out to deal with the elements of behaviour; apart from learning in Arthropods, reviewed by Thorpe[1], I doubt if enough is yet known to justify a treatise on invertebrate behaviour in this plane. We were, however, able to deal with some aggregations in which animals react to components of a situation other than each other.

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[1] Thorpe, W. H., *Brit J. Psychol*, 33, 220, 34, 20 (1943)

Moulting Fluid of Woodlice

IT is well known that in insects during the process of moulting or ecdysis there is a thin plasma or moulting fluid. "When the epidermal cells separate from the old cuticle and begin to secrete the new, the space between the two cuticles is occupied by a thin plasma. In the later stages of moulting this space is filled by an abundant fluid, the moulting or ecdysial fluid, first clearly demonstrated by Newport. There can be little doubt that much of this fluid, which extends also throughout the tracheal system, arises by exudation from the epidermal cells; indeed, this has sometimes been its sole source. But the epidermis of the majority of insects contains numerous glands which become active only at the time of moulting and certainly contribute to the secretion of the fluid."[1]

In the literature on moulting of the woodlice, I have failed to find in the writings of Schobl, Friedrich, Leichmann, Němec, Schonichen, Herold and others any reference to such a fluid in these isopods. Recently, I have had occasion to mount small pieces of the exuviæ recently cast by *Armadillidium vulgare* (Latr.), and I noticed that they seemed to adhere to the glass slide; on being removed a faint film was noticeable where each fragment had been. In longitudinal sections of *Porcellio dilatatus* Brandt, the epidermal cells show numerous glandular ones, which, I suggest, may give rise to this plasma. Moreover, in the space between the cuticle and the epiderm there is a uniform, thin streak of non-cellular matter This was present in all the sections. Finally, exuviæ, in alcohol, show a thin glistening substance on their inner side.

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Wigglesworth, "Principles of Insect Physiology" ,25 (1939).

RESEARCH ITEMS

Corpora Lutea in Elasmobranchs

THE fact that in an elasmobranch, *Myliobatus bovina*, after ovulation the follicle is transformed into a glandular organ was first reported by Giocomini in 1896. The formation and structure of this gland in another batoid, *Rhinobatus granulatus*, investigated more fully and by more modern methods, have been recorded by Miss Mary Samuel (*Proc. Indian Acad. Sci.*, 18; 1943). This gland, a corpus luteum, is formed after the discharge of the ovum in a manner homologous with that in mammals. The luteal cells are derived from the follicular epithelium and invading cells of the theca interna, while intrusions of the theca externa accompanied by blood vessels without either the hypertrophy or luteinization of its cells provides a framework. It is noted that the fully formed corpus closely resembles that of a mammal, but it also has its own distinctive characteristics. In the mammal the corpus luteum is associated with the maintenance of pregnancy, a typical mammalian function, and its presence in an active state appears to suppress ovulation. Miss Samuel, however, records that each ovary in *Rhinobatus* may contain twenty corpora lutea in all stages of development, from newly formed to fully active glands and also maturing follicles.

Primitive Fishes

THE late Dr. Bashford Dean left an extensive and valuable collection of notes and drawings on various groups of the archaic fishes. The American Museum of Natural History very wisely decided to have this material worked up in the form of a Bashford Dean Memorial Volume, which they entrusted to the able editorship of Dr. E. W. Gudger. The last two articles of this work are just to hand, and the extent of the whole work has rendered it necessary to bind the volume in two parts. Article 7, by E. W. Gudger, is on the breeding habits, reproductive organs and external embryonic development of *Chlamydoselachus* and is illustrated by six plates and 33 text-figures. Article 8, by B. G. Smith, is on the natural history of the heterodontid sharks and the external development of *Heterodontus japonicus* and is illustrated by seven plates and 69 text-figures. The plentiful material for both these memoirs was obtained in Japan by Bashford Dean, and both contain valuable contributions to our knowledge of these rather rare, primitive sharks. The two authors and the American Museum are to be congratulated on rescuing this work from oblivion, and it is a pleasure, in these times of stress, to handle publications that are presented in such a splendid form.

Serious Fungoid Disease of British Mackerel

NORA G. SPROSTON describes the occurrence and life-history of *Ichthyosporidium Hoferi* in mackerel mainly landed at the Plymouth Laboratory (*J. Mar Biol. Assoc.*, 26, 72; 1944) The presence of the fungus, which has been recorded from trout in Germany, from herring in the Gulf of Maine, and which probably occurs in several British marine fishes, is indicated in the mackerel by necrosis of the viscera with the production of a thick brown fluid, but there are no external signs of lesion or colour change. In the four years 1940–43, when samples were examined, the incidence of the disease continued to be high; and since it renders the fish inedible, the suggestion is made that mackerel should be split and gutted and at once packed in dry crushed ice. The opening of the fish would at once reveal badly infected individuals, which should be discarded. The main part of the paper describes the profuse forms developed by *I Hoferi* in the mackerel —chlamydospores, conidia, hyphal bodies, branched conidiophores, clavate sporangia, hyphal fusions, spores produced by hyphal fusions—several of which are described for the first time There is no need for an intermediate host, and infection in the sea may be spread by living individuals or from dead fish or discarded offal of diseased individuals. Within an individual an infection spreads throughout the viscera by way of the blood stream, kidney and spleen eventually breaking down and blood vessels becoming toughened by the hyphæ and nodules of the parasite. Only in very advanced cases do the body muscles degenerate.

Management of Honey-bee Colonies

CIRCULAR No. 702 of the U.S. Department of Agriculture by C. L. Farrar deals with the above subject in the northern States. It is pointed out that the trend in bee-keeping practice in recent years has been to increase the number of hives in an apiary, with less attention to individual colonies. As a consequence, most commercial apiaries are reporting average yields of about one third of those obtained from maximum-producing colonies The most effective way to lower production costs is through increased colony yields. This Circular gives the necessary information on practices that will give the best returns from each colony. In the northern States the equivalent of not less than two ten-frame hive bodies should be used to house the colony during the winter, and not less than five during the active season. The colony to be overwintered should have a gross weight of not less than 130 lb. and consist of a laying queen along with 8–10 lb. of bees that emerged after August 20. The hive should contain not less than 40 lb. of honey in the upper body with pollen and some empty cells in the centre, and 20–30 lb. of honey and as much pollen as conditions allow in the lower body. The development of colonies inadequately provisioned with pollen can be increased by feeding pollen supplemented with 75 per cent of soybean flour. The bee-keeper should be familiar with the sources of pollen and nectar in his locality. During the active season the object is to build maximum populations for the honey flow and maintain them throughout the season. The most populous colonies produce not only the most honey per hive but also the most honey per bee. Brood-rearing is the basis of colony development and the maintenance of maximum populations during the flow.

Yew Scale

G. FOX WILSON has described the life-history and control of the yew scale, *Lecanium corni-crudum* (*J. Roy. Hort. Soc.*, 69, Pt. 8; Aug. 1944). The pest is at present distributed in the south of England. Attacks are mainly recognized by the presence of black honey dew on the shoots—black because of the presence of sooty mould fungi. Eggs of the pest are laid towards the end of June and hatch during the summer. Overwintering is usually accomplished as second-stage larvæ. Dispersal of the insects may be effected by birds, wasps and bluebottles, in addition to the distribution of infected plants. Control has been accomplished by spraying with a nicotine and white oil emulsion in autumn and spring.

Genetics of Cultivated Species of Cucurbitaceæ

C. F. Poole (*J. Hered.*, **35**, 122; 1944) summarizes the genetics of the water melon, cucumber and musk melon since 1937, when a summary was published in the Year Book of the U.S. Department of Agriculture. Upwards of twenty-five different qualitative characters and thirteen genes associated with fruit weight have been isolated in the water melon, and seventeen characters in the cucumber are now determined to be controlled by genes. Resistance to disease, sex determination and chlorosis are also partly analysed in respect of their inheritance. Of particular interest is the evidence that transmission of a mottling of leaves and fruit is by means of plastids and that an abnormal plastid may be carried by the pollen tube. Linkage relationships and gene interactions are also reported.

Barley-Rye Hybrids

R. A. Brink, D. C. Cooper and L. E. Ausherman (*J. Hered.*, **35**, 67, 1944) report the results of some interesting experiments in wide hybridization. The hybrid embryos of *Hordeum jubatum* with *Secale cereale* cease growth at 6–13 days after fertilization if they are left on the mother plant. If the embryos are dissected and grown in artificial media, they continue growth; 33 out of 81 such embryos developed in an undifferentiated manner, but one developed normally and was grown to maturity. These experiments confirm the view that infertility frequently arises from the non-functioning of the hybrid endosperm and not from the hybrid zygotes. The cytological examination of this unique hybrid indicates little homology between the chromosomes and the parents, but the characters of the hybrid were intermediate between those of the parents.

Statistics of Field Experiments

E. A. Cornish (*Bull.* 175), and I. E. Phipps, A. T. Pugsley, S. R. Hockley and E. A. Cornish (*Bull.* 176, *Aust. Coun. Sci. and Indus. Research*) have extended the statistical analysis of Fisher and Yates to lattice squares and cubic lattice designs, and suggest methods for use where the data are incomplete.

Synthetic Morphine Substitutes

Experience with synthetic œstrogens has proved useful in the search for synthetic substitutes for morphine. The naturally occurring œstrogens all have the same basic ring structure; they differ only in the position of double bonds and polar groups. So the discovery of synthetic œstrogens such as stilbœstrol which did not possess this ring structure but which nevertheless were chemically related, though somewhat distantly, to the natural œstrogens, was somewhat surprising and opened up new fields of investigation. E. C. Dodds, W. Lawson and P. C. Williams (*Proc. Roy. Soc.*, B, **132**, 119; 1944), realizing that morphine has a phenanthrene ring structure somewhat similar to that of œstrone, have synthesized a number of analogues which bear roughly the same chemical relationship to morphine as does stilbœstrol to œstrone, and have shown that some of these analogues have morphine-like properties. The synthetic substances investigated were diphenylethylamine and seventeen other related compounds. From the clinical point of view the most promising one discovered was β-hydroxy-αβ-diphenyl ethylamine, which, in 4-hourly doses of 200–400 mgm. by mouth, relieved pain as effectively as morphine. It remains to be seen whether such substances are habit-forming.

Possibility of Aurora in a Comet's Tail

Julie M. Vinter-Hansen has written in the *Publications of the Astronomical Society of the Pacific* on some interesting comet observations, and a short account of the article is given in *Sky and Telescope* of June. On March 29, 1943, Arend, at Uccle, noticed a nebulous object of 13th magnitude with a nucleus, and the object was close to Comet Whipple (1942*g*). Subsequent measurements showed that its position must have coincided with that of the comet on March 28·5. Dr. Brunner-Hagger, at Zurich, had photographs of the comet on nearby dates, and these confirmed the view that the nebulous object had split off from the comet on March 28·5. On March 27·8 a fine aurora was seen, and from the time which elapsed between the appearance of the aurora and formation of the cometary object, it was deduced that the solar corpuscles, which are responsible for the auroras, travelled at the rate of one astronomical unit in about 30 hours. It is known from other evidence that this is near their speed, and the presumption that corpuscles shot off from the sun were responsible for disintegrating a portion of the comet's tail is strong. Other photographs of the comet showing similar spots were available for the period February 28–March 4, and solar eruptions had occurred during February 26–28; similar velocities were found for the corpuscles during this period. The view advocated may throw some light on the erratic behaviour of some comets in their sudden variations in magnitude.

Problem of U Cephei

It has long been known that insuperable discrepancies exist between the orbit of the eclipsing binary U Cephei determined from its light curve and the orbit found spectroscopically from its velocity curve, if both curves are interpreted in the standard way. O. Struve now gives the results of a new determination of the velocity curve made with the 82-in. McDonald reflector (*Astrophys. J.*, **99**, 222; 1944). It is confirmed that, unlike the light curve, the velocity curve is distinctly unsymmetrical, by an amount which no permissible adjustment of the elements can remove. Struve tentatively suggests that this asymmetry may be produced by absorption in a stream of gas which starts from the *B*8 star and passes along the following side of the *G*2 star, to return toward the *B*8 star along the preceding side of the *G*2 star. Superposed lines of H and Ca II which appear in the partial phases seem to need the postulation of just such a stream. The following paper (*ibid.*, p. 239) by Kopal, however, points out that several eclipsing binaries besides U Cephei have conflicting spectroscopic and photometric orbits. *Ad hoc* interpretations of each are obviously undesirable. A more general explanation is needed which will attribute the distortion of the velocity curve to some peculiar distribution and motion of matter in the outer envelopes of the stars where the density is so low that the distribution of mass remains unaffected and no dynamical perturbations are produced. So long as the matter remains in doubt, the conventional spectroscopic elements should be regarded as parameters which do not readily admit of dynamical interpretation. It is disturbing to realize that ordinary (that is, non-eclipsing) spectroscopic binaries may have their orbital elements vitiated in the same way without any indication that they are so vitiated.

ANTIBACTERIAL ACTIVITY OF AMŒBÆ

THOSE who have followed the development of research on penicillin and other substances which inhibit the multiplication of micro-organisms will be familiar with Sir Alexander Fleming's discovery (*Brit. J. Exp. Path.*, 10, 226; 1929), that staphylococci cultured on a plate culture failed to develop around an accidental contamination with the mould *Penicillium notatum* and were undergoing lysis, and that culture fluid taken from a culture of *P. notatum* would, even when it was diluted 500–800 times, completely inhibit the growth of the staphylococci. This work, together with other work on penicillin and on various antibacterial substances derived from bacteria and moulds (for example, pyocyanine, gramicidin, actinomycin, aspergillic acid, helvolic acid, etc.), has been summarized in the *British Medical Bulletin* (2, No. 1; 1944) and elsewhere. In bacterial cultures in which these antibacterial substances are present, areas in which the bacteria fail to develop appear, which are sometimes called 'clearance areas'. Protozoologists have been aware for many years that certain amœbæ ingest readily certain kinds of bacteria, yeasts and similar organisms, and that they can, under appropriate cultural conditions, produce in bacterial cultures 'clearance areas' somewhat similar to those produced by the antibacterial products of moulds and bacteria. The two phenomena are, however, quite distinct. While the amœbæ clear parts of the cultures by actively ingesting the bacteria, the antibacterial products of moulds and bacteria clear them by inhibition of the bacterial growth, or even by lysis of the bacteria.

The clearance of certain areas of bacterial cultures by the active ingestion of the bacteria by an amœba has been studied by Sir Aldo Castellani (*J. Trop. Med. and Hyg.*, 33, 160, 188, 221, 237; 1930, and 34, 83; 1931). Castellani first recorded his study of the active ingestion of the pink yeast, *Cryptococcus pararoseus* (Cast.), by an amœba which was named *Hartmanella castellanii* by M. Douglas (*J. Trop. Med. and Hyg.*, 33, 258; 1930). Castellani found that pure cultures of this amœba could be obtained by growing it on glucose-agar smeared with the dead yeast. He also found that, when amœbæ were inoculated on to a growth of certain bacteria, after a few days a zone of clearing of the culture appeared which radiated from the point of inoculation of the amœba. Such zones of clearing appeared in cultures of *B. typhosus*, *B. paratyphosus* A and B, *B. dysenteriæ* Shiga and Flexner Y, some strains of *Vibrio paracholeræ* and *B. pestis*, but not on cultures of *B. proteus*, *B. pyocyaneus*, *B. morgani*, *Brucella melitensis*, some strains of *Vibrio choleræ* and all strains of *Staphylococcus* that were tried. The amœbæ sometimes cleared bacteria (for example, *B. coli*), while at other times they did not. Douglas (*loc. cit.*) confirmed these results in the main.

C. E. van Rooyen (*J. Trop. Med. and Hyg.*, 35, 118 and 259; 1932) studied further this activity of *H. castellanii*. He found that the clearing of the yeast and bacteria by the amœba is due to ingestion of these organisms, and not to a diffusible lysin produced by the amœbæ or to a change in the *p*H of the culture; nor is the action of the amœbæ related to the action of bacteriophage. The rate of destruction of the bacterial culture is proportional to the thickness of the bacterial growth. Van Rooyen confirmed Castellani's discovery that the amœba eats certain bacteria only and will not eat others. He gives a list of about fifty micro-organisms which he subjected to the action of the amœba, most of which are important pathogenic organisms affecting man and domestic animals. The amœbæ were able to destroy, after four days of aerobic incubation at 26-30° C., *B. typhosus*, *B. coli*, *V. choleræ*, *V. paracholeræ*, *B. dysenteriæ* Shiga, *B. pullorum*, *B. suisepticus*, *B. pertussis*, *D. crassus*, *Micrococcus catarrhalis*, *Gonococcus* and *Meningococcus*. To a lesser degree they devoured *B. aertrycke*, *B. suipestifer*, *Streptococcus hæmolyticus*, *B. subtilis* and some strains of *Pneumococcus Type* II. The following were not affected by the amœba: *V. choleræ*, *B. morgani*, *B. fæcalis alkaligenes*, *B. dysenteriæ* Flexner, *Staphylococcus*, *Pneumococcus Type* III, *B. hoffmanni*, *B. xerosis*, *B. pseudotuberculosis ovis* (Preisz), *B. anthracis*, *B. mycoides*, *B. mesentericus*, *B. abortus* (Bang), *B. melitensis*, *B. tuberculosis* (human, bovine, porcine and fish strains) and R and S variants of the same), *B. lepræ* (Brinkenhoff) and *B. salmonicida*.

Staphylococcus aureus was used to investigate why the amœba did not eat certain organisms. It was found that substances produced by the staphylococci inhibited the growth and multiplication of the amœbæ. Cultures of *S. aureus* killed and washed in saline were readily eaten by the amœba. The amœba also readily ate killed and washed cultures of the following other organisms which they did not eat when they were alive: *B. proteus* X 19, *B. morgani* No 1, *B. pyocyaneus*, *B anthracis*, *B. anthracoides*, *B. lepræ* (Brinkenhoff) and other organisms. The amœba ate mixed cultures provided that these contained either only susceptible bacteria or resistant ones rendered susceptible by killing and washing. The age of the bacterial culture did not make any difference to the ingestion of them by the amœba. The amœba is a strict aerobe and cannot multiply in anaerobic cultures. It will be noted that the bacteria which the amœba will or will not eat do not fall within the Gram-positive and Gram-negative classifications.

Filtrates of saline washings derived from bacteria which the amœbæ will not eat were unable to inhibit the growth and multiplication of the amœba; they did this only when they were combined with the living bacteria and were being produced by them. In certain circumstances the appearances produced by the amœbæ in cultures of bacteria which they will eat resemble closely those produced by bacteriophage action and may be indistinguishable from those of bacteriophage actions except by examination under the low-power microscope. The amœba is extremely resistant to emetine hydrochloride for long periods of time, and prolonged exposure (2 hr. at 75 cm. distance) to X-rays does not kill it.

It seems likely that further work with this species of amœba, and with other species also, would increas the biological interest of these results. It might throw light on the metabolism of amœbæ in general; and, when we remember that the phagocyte is an amœba actively engaged in ingesting and destroying bacteria which are causing disease, the effects of bacterial products on amœbæ in bacterial cultures are perhaps worth further study. It may be argued that studies of a free-living amœba in the presence of pathogenic and other bacteria in artificial cultures will not be applicable to the phagocyte confronted with pathogenic bacteria in the body, but this remains to be proved. At any rate, the work of Castellani

and van Rooyen provides the basis for studies of this kind. While we have, in penicillin and allied substances, instances of the action of metabolic products of an organism on bacteria, we have, in the work here recorded, an instance of the reverse process—the action of bacterial metabolic products on an amœba physiologically equivalent to the phagocyte, which is not, fortunately for us, affected by penicillin. The work of Castellani and van Rooyen brings us, in fact, nearer to the work on the opsonins and similar substances—work which aimed at rendering the invading bacteria more palatable to the amœbic phagocyte, or at any rate aimed at helping the ingestion of these bacteria by the phagocyte. It is possible that the work done with *H. Castellanii* might be best developed with this idea as its basis.

G. LAPAGE.

AGRICULTURAL SAMPLE SURVEYS

THE need for adequate statistics relating to our agricultural resources and requirements must have become obvious to all during the last few years, for the urgency of war problems has served to direct attention to the inadequacy of peace-time data and also to the methods of rapidly filling the deficiencies. Complete and reliable censuses are often impracticable and always make great demands on both time and skilled labour. Where the need is more for a quick and reasonably accurate estimate of crop acreage, yield, or whatever it may be, sample surveys will generally offer a better method of obtaining the data. These set out to arrive at an estimate of the whole from the collection of a limited sample of representative parts. The dangers of such an approach are as clear as the advantages, and only by conducting the sample surveys along sound statistical lines can biased or distorted estimates be avoided and a measure of the reliability of the estimate be secured.

The need for information of the kind given by sample surveys is, of course, confined neither to Great Britain nor to war-time. In 1937 a statutory body called the Indian Central Jute Committee initiated, as one of its first tasks, a five-year scheme for obtaining improved estimates of the area under jute in Bengal. After some hesitation it was decided to use the sample survey method, the earlier years being devoted to small exploratory surveys, with a complete survey of about 60,000 square miles in 1941. It was laid down that the final estimate of area under jute should have a margin of error not exceeding 5 per cent, that it should be ready early in the jute season and that the cost should not be excessive P. C. Mahalanobis, who was statistical adviser to the scheme, has now published an account of the methods, both organizational and statistical, by means of which the task was successfully accomplished. The final estimate was within 2·8 per cent of an independent official estimate based on census data; it was ready a week or so before the latest useful date; it cost only about £8,500 as against £110,000 for a complete census. In view of this the Jute Census Committee recommended the adoption of sample surveying to the Indian Government.

Mahalanobis' paper ("On Large-scale Sample Surveys", *Phil. Trans. Roy. Soc.*, B, **231**, 329–451) is divided into three parts. Part 1 describes the way in which the problem arose, outlines the method of approach and discusses production and mapping surveys in addition to those concerning acreage. Part 2 is a mathematical treatment of the statistical theory of various methods of sample surveying. The concepts and principles are dealt with mainly in the abstract, but the results of model sampling experiments are also used Part 3 concerns the application of this theory to crop area estimation, especially the jute survey of Bengal The experimental results are summarized and numerical examples worked out.

The fields under jute in Bengal vary much in size, and furthermore any field may be only partly devoted to this crop. It was therefore decided to take as the sampling unit areas, termed grids, of a definite size, like four or twenty acres. The proportion of the land given to jute in each grid was ascertained, and by combining these proportions from all the grids, which were randomly located over the jute-growing area, an estimate of the jute acreage was obtained. Both the precision and the cost of this estimate depend on the area of each grid and the number of grids (that is, density per square mile) surveyed. Now for any given cost, the larger each grid is, the smaller is the density that can be used. The problem is then to adjust grid size, and with it density, so as to maximize the precision of the final estimate The alternative procedure, which though discussed was not used for the jute survey, is to adjust grid size and number to minimize the cost for a given level of precision.

Two functions, relating cost and precision (variance) to grid size and number, were set up. The constants which they contained were estimated empirically from the data of the early exploratory surveys and by their aid the final survey was planned. The cost function was found to involve consideration of time necessary for enumerating the jute areas within each grid (which depends on grid size but not on density), of time necessary for journeying from grid to grid (which depends on density but not size), of miscellaneous time (independent of both size and density) and of time needed in the statistical laboratory. The precision, or variance, function was found to involve a parameter which took into account the correlation of cropping on adjacent fields. It was also shown that precision varied with proportion of land under jute in the grid, so that the adjustment of grid size and density best for one proportion would not be best for another. For this reason the area to be surveyed finally was divided into zones of more or less homogeneous proportions of jute land, and the best grid sizes and densities found for each zone separately.

Linked pairs of sub-samples, at constant distances apart but randomly orientated, were used to give the standard error of the final estimate. These were always surveyed by different groups of enumerators and at different times, so as to prevent collusion.

The laboratory methods of organizing the survey and randomizing the grids are described in detail, as are the kinds of errors arising from untrained and even dishonest enumerational labour. The means used to adjust the work to the very varied speeds of the enumerators are also mentioned. In the discussion of the planning of sample surveys it is emphasized that surveys of the kind undertaken are progressive. Each one adds to the information relating to the cost and precision functions and their changes with zone and time. So each enables a better survey to be planned for the next occasion. Finally, a detailed account of the work of others on survey sampling is appended.

IDENTIFICATION OF TIMBERS

TWO leaflets have recently been issued under the auspices of the Department of Scientific and Industrial Research by the Forest Products Research Laboratory, Princes Risborough · No. 34 on "The Identification of Timbers", and No. 37 on "Selecting Ash by Inspection" (H.M Stationery Office, London, 1944) Leaflet No. 34 is intended to be a rough-and-ready guide to the identification of timbers. Its aim is the temporary one of taking the place of more elaborate text-books and official publications at present practically unobtainable. As is well known, owing to the demands of the War, a number of new or at least unfamiliar timbers are being used in Great Britain, and it is at times difficult for those wishing to do so to identify timbers the use of which is permitted by official specifications. General appearance, colour, texture, weight and smell, etc., are useful aids to the *cognoscenti*, but more reliable tests are based on the characteristic structural features remaining unaltered under conditions which may entirely change the external appearance of the timber. The object of the leaflet is to describe and illustrate the principal structural features of wood and to explain how they can be used in identifying timbers in the factory or office with the minimum of apparatus and little or no previous experience.

The text first describes the type of sample required and its method of preparation for examination, the sample being of a size convenient for handling. Details are then given of the structure of wood, heartwood and sapwood, softwoods (conifers) and hardwoods, structural features of softwoods and the same of the hardwoods. Two tables descriptive of the chief features of certain species are given, one for softwoods (larch, Scots pine, Douglas, western hemlock, spruce, noble fir, western red cedar and Parana pine) and the other for hardwoods (oak, sweet chestnut, ash, elm, beech, birch and sycamore). Two plates show photographs of cross-sections (magnified $\times$ 10) of some of the species mentioned above.

Leaflet No. 37 deals with ash. The importance of ash depends largely on its mechanical properties, notably its toughness, high resistance to shock and the readiness with which it can be shaped by steam and bending. These properties are subject to considerable variation, and it is of importance to users that they should be able to judge the quality of the timber whether in the standing tree or in the conversion thereof. Mechanical testing has various inherent and obvious drawbacks, and in any event involves standardized equipment and the waste of a considerable proportion of the timber. It is therefore usually necessary to fall back on visual methods of inspection and other simple tests.

The investigations dealt with in the leaflet are made on English ash (*Fraxinus excelsior*), but generally they cover other kinds of ash commonly imported into the United Kingdom, the *Fraxinus excelsior* of Continental Europe and the American ash (various species of *Fraxinus*). Shippers usually allude to American ash as 'tough ash' or 'cabinet ash'. The better grades of the former are suitable, or at any rate are used, for many of the same purposes as well-grown English ash, and are widely used in normal times by the automobile and agricultural implement industries, most of the good ash in Britain having been hunted down and felled during the War of 1914–18.

The leaflet discusses this matter of selection of ash by inspection under the headings of factors affecting the quality of the timber, structure as an indication of quality, density, selection of standing timber and winter- and summer-felled timber. As regards selection, trees with a good length of straight clean bole, clear of side-branches and with a well-developed healthy crown at least one half the height of the tree should be chosen. Such trees are likely to be found in fairly open woodland and are preferable to those grown in crowded woods The prejudice against summer-felled timbers, the writer says, is mainly due to the fact that weather conditions in summer favour the occurrence of splits and checks owing to too rapid drying. Provided that the logs can be taken to some spot where they can be stored in sheltered conditions, there is no need to discriminate between spring- or summer-felled timber.

AMERICAN INDIAN STUDIES

BULLETIN 136 of the Bureau of American Ethnology (Smithsonian Institution) consists of a further series of six anthropological papers dealing with the American Indian and allied subjects.

Miss Frances Densmore contributes two more papers to her long series on the music of the American Indian. The first deals with the Indians of British Columbia, and is noteworthy as being her first work in Canada. Unlike most of her earlier papers, it deals with many tribes, being the product of a visit to a hopping centre where Indians from widely separated localities were at work. The music of the Choctaw Indians of Mississippi is the subject of the second paper. The investigation was prompted by the discovery that the songs of the Yuma Indians have a definite form, consisting of several periods recurring in regular order, a peculiarity which was afterwards found to occur sporadically among the Pueblos and the Seminoles, and as far away as the Tule Indians of San Blas, Panama. This characteristic, described as "period formation", was found also among the Choctaw, particularly in songs inferred to be ancient. Numerous songs were recorded

A paper entitled "Ethnological Data concerning 100 Yucatan Plants", by Morris Steggarda, is based on a collection made by him in the area occupied by the Maya Indians, near Chichen Itza. Having eliminated 125 species, about which the available data had already been published, he prepared this interesting report on the remaining 100, so the information in it is entirely new. The body of the report consists of a catalogue, arranged in alphabetical order of scientific names, giving notes on the uses to which each is put by the Maya. This is followed by an alphabetical list of Maya names, and the paper ends with a discussion of the uses of the plants. Some are used, of course, for the production of various necessary objects and ornaments, but the greatest number are employed in the treatment of disease. It appears that the yerbateros, or herb doctors, have little scientific knowledge on which to base their treatments, which are in consequence a mixture of folklore, superstition and herbal concoctions, of which few have any curative value.

Steggarda is also responsible for "A Description of 30 Towns in Yucatan, Mexico", consisting of topographical and historical notes on a selection of the towns and villages he has visited. This should be useful to intending travellers in the area. (The first

line of the description of the village of Mani is repeated at the beginning of that of Mama, where it does not make sense.)

Julian H. Steward's paper on Western Shoshoni myths does not claim to be exhaustive, but is published because information from this tribe in Nevada and eastern California was lacking. The tales are not new for the most part, and local variation is their most interesting feature, so as many different versions of the same tale as possible were collected. The title of one version of the "Theft of the Pine Nuts" story is misprinted "The Origin of People".

The last paper, by Leslie A White, on new material from Acoma, is a supplement to his book on the Acoma Indians, and contains miscellaneous information obtained since its publication. It includes a brief autobiographical sketch of an Indian, preceded by some particularly interesting notes on the mentality of the Pueblos, which sum up the difficulty of obtaining such material in the words "The autobiography of a Pueblo Indian is about as personal as the life story of an automobile tire"!

G H. S. BUSHNELL.

THE STONE AGE IN SOUTH AUSTRALIA

A COLLECTION of reprints, all concerned with the stone age industries from certain parts of Australia, has been received*. The novel feature is the collaboration of Mr H. V. V. Noone, who is an expert in the typology and technology of the older stone age industries of western Europe, and who therefore ensures that descriptive terms used there shall not be employed to describe something different in the Antipodes. This is very important, as heretofore there has always been the danger that, for example, Australian tools described as burins might not really be burins at all. There are few good collections of European stone age industries in Australia, and Australian prehistorians have had to judge solely from pictures—never a very safe proceeding. If any kind of comparative work is to be done, a proper use of sensible descriptive terms universally is a *sine qua non*. It is to be hoped, then, that the above collaborators will extend their activities to other parts of Australia as well.

Similar needs engender similar tools to deal with these needs, and it does not follow that there is any cultural connexion between distantly separated areas because more or less similar tools occur in both. The same may be said of simple industries. Where the industries in the two areas, however, are complex and contain a number of specialized tools, the situation is altered and some cultural connexion may be postulated. Hence the necessity for accurate descriptions and descriptive terms.

In studying Australian stone age collections, one notes the not infrequent occurrence of pigmy types —triangles, crescents, tiny round scrapers, and the like. As these resemble not a little types occurring in the mesolithic industries of western Europe, prehistorians have been tempted to make close comparisons. Actually great care must be taken, because the occurrence of a pigmy industry denotes nothing more than the development of the composite tool—one in which the haft is made of some suitable material such as wood and the 'business' parts of flint and suchlike substances. Such composite tools could be, and were, developed at different times in different parts of the world. Their development probably depended largely on the incoming of climatic conditions allowing of the growth of soft-wood forests. The pigmy industries of Central India would seem to date from a century B.C. to the tenth century A.D, and those from Ceylon are also not very ancient. It must not be assumed, then, that the pigmy element in the Australian stone age industries is necessarily very old. Once the idea of the composite tool had been adopted, only a few types of pigmy artefact would be suitable—a chipped circle or square would be useless. The only form typical of the western European mesolithic cultures, and not occurring in India, Ceylon or Australia, seems to be the micro-burin.

Students interested in the comparative typology and technology of stone age industries should take note of the above-mentioned excellent descriptive articles.

M. C. BURKITT.

* Campbell, T D, and Noone, H. V V, "South Australian Microlithic Stone Implements", *Rec S Aust. Mus*, 7, No 3 (May 30, 1943). Campbell, T D, and Noone, H V V., "Some Aboriginal Camp Sites in the Woakwine Range Region of the South-East of South Australia", *Rec. S Aust Mus*, 7, No 4 (Nov 30, 1943). Noone, H V V, "Some Aboriginal Stone Implements of Western Australia", *Rec. S. Aust. Mus*, 7, No 3 (May 30, 1943) Noone, H V V, "Australia. Material Culture", *Mankind*, 3, No 5 (Dec 1943)

EFFECT OF HORMONES ON PLANT DEVELOPMENT

SINCE it has been shown that synthetic growth substances will supply the stimulus necessary for continued ovary development and hence fruit development in a number of plants, various attempts have been made to increase 'fruit set' in both 'fruits' and vegetables by the use of hormones. These attempts have met with varying degrees of success. L. Greene (*Proc. Amer. Soc. Hort. Sci.*, 42, 149; 1943) finds that a number of growth substances applied as sprays, lanoline pastes and injections to Starking apples failed to increase fruit set.

Similar negative results are reported by C. S. Pomeroy and W. W. Aldrich (*ibid.*, 42, 146; 1943), using naphthyl acetic acid on orange and grape fruit, although with the marsh grape fruit used, pollen of other grape fruit varieties did increase the set of fruit; on the other hand, R. H. Roberts and B. E. Struckmeyer (*ibid.*, 44, 417, 1944) found that aqueous solution of β-naphthoxy acetic acid and 2:4 dichlorophenoxy propionic acid sprayed on to tomato flowers induced fruit setting. *O.* chlorophenoxy propionic acid was less effective but both phenoxy-acids caused distortion of the foliage.

The use of the sprays did not prevent fruit or flower abscission due to virus or to nutritional deficiencies. Favourable results from the use of these sprays were also found with pumpkins, outdoor cucumbers, egg-plant and *Nicandra physaloides* but not with apple (nine varieties), greenhouse cucumbers, peppers, potatoes, or strawberries.

In field experiments of a similar nature carried out by A. E. Murneek, S. H. Wittwer and D. D. Hemphill (*ibid.*, 44, 428; 1944) on snap beans, using naphthylacetamide and naphthoxyacetic acid applied as a spray to the plants every second or fifth day, increases in fruit yields were obtained in hot years, but decreases in cold years, emphasizing the importance of environmental conditions in determining the nature and extent of response to the treatments.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Saturday, February 10

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, London, S W.7), at 3 p m —Mr J Yarwood · "The Deposition of Metal Films—their Application to Colour Photography".

Monday, February 12

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W C.2), at 2 30 p m.—The Earl De La Warr "British Agriculture and World Conditions".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S W.7), at 8 p m.—Mr C Hope Gill "The People and Country of Ethiopia" (with Kodachrome Film)

Tuesday, February 13

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 1.30 p.m.—Prof. V. Minorsky. "The Tribes of Western Persia".

CHEMICAL ENGINEERING GROUP (SOCIETY OF CHEMICAL INDUSTRY) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 2 p.m —Mr J. Watson Napier · "Ammonia Synthesis from Coke Oven Gas".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p m.—Sir George Dyson · "The Origin and Development of Early Musical Forms", (1) "The Elizabethan Period".

INSTITUTION OF CIVIL ENGINEERS (MARITIME ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W.1), at 5.30 p m —Mr. A L. Harvey: "Two New Quays at Tyne Dock, South Shields".

ILLUMINATING ENGINEERING SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S W 1), at 6 p.m —Discussion on the Report of the D.S I R. Committee on "The Lighting of Buildings" (Post-War Building Studies, No. 12) (to be introduced by Dr C C Paterson, F.R.S).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, London, S W.7), at 6 p m.—Mr. Stuart Williamson: "Trends in Air-Camera Design".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C 2), at 7 p.m.—Dr W. Wilson "The Cathode Ray Tube and its Applications".

Wednesday, February 14

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p.m.—Prof. Owen Thomas Jones, F R.S., and Prof. William John Pugh. "The Complex Intrusion of Welfield Rocks near Builth Wells, Radnorshire"; Dr. Frank Dixey: "The Relation of the Main Peneplain of Central Africa to Sediments of Lower Miocene Age".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 3 30 p m —Prof G Grey Turner · "The Hunterian Museum, Yesterday and To-morrow" (Hunterian Oration).

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W C.2), at 5 30 p m. —Mr. R C Hatton and Dr J. McCombe "The Operation, Maintenance and Testing of Overhead Lines and Associated Outdoor Equipment on A C. Systems".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 30 p m.—Wing-Commander T R Cave-Browne-Cave: "Camouflage for the Concealment of Civil Factories".

BRITISH ASSOCIATION OF CHEMISTS (at Caxton Hall, Westminster, London, S.W.1), at 6.30 p m —Prof. Harold Laski. "The Place of the Scientist in Post-War Administration".*

Thursday, February 15

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Mr. L. C Bateman, Dr. E. D. Hughes and Prof. C K. Ingold, F.R S.. "Molecular Compounds between Amines and Sulphur Dioxide, a Comment on Jander's Theory of Ionic Reactions in Sulphur Dioxide"; Mr. S H. Harper: "Experiments on the Synthesis of the Pyrethrins, Part 1, Synthesis of Chrysanthemum Monocarboxylic Acid"; Mr. N Barton, Mr. G. L. Buchanan, Prof. J. W. Cook, F R S., Mr. W Graham and Mr. J. D. Loudon "Studies on the Chemical Constitution of Colchicine"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 15 p m —Prof. James Gray, F.R S.. "Locomotory Mechanisms in Vertebrate Animals", (3) "Nervous Control of Movement".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S.W.1), at 6 30 p m.—Mr. J. Wright "Aircraft Wheels and Brakes".

Friday, February 16

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. F. Wood Jones, F.R S.: "The Mammalian Toilet".

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C 2), at 5.30 p m. —Mr. D. J. Desmond: "The Economic Utilization of Modern Permanent Magnets".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W 1), at 5.30 p.m.—Annual General Meeting. Dr. J. Lockwood Taylor: "The Variable-pitch Marine Propeller".

Saturday, February 17

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Institution, Albemarle Street, London, W 1), at 2 30 p m. —Dr R E Slade "The Organisation of Research in Industry".

Saturday, February 17—Sunday, February 18

ASSOCIATION OF SCIENTIFIC WORKERS (at Caxton Hall, Westminster, London, S W 1)—Conference on "Science in Peace"

Saturday, February 17

At 2 15 p m —"Science and Production" (Chairman: Prof. P. M. S. Blackett, F.R S)

Sunday, February 18

At 10 a m —"The Future Development of Science" (Chairman. Sir Robert Watson-Watt, F R S).

At 2 30 p m.—"Science in Everyday Life" (Chairman: Prof. H. Levy).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned ·

CHIEF LECTURER IN THE MINING DEPARTMENT—The Registrar, Technical College, Sunderland (February 16).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS for the Day School of Engineering and Part-time Day and Evening Classes—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W 4 (February 17)

LECTURER (full-time) IN CHEMISTRY in the Science Department, and an ASSISTANT MASTER OR MISTRESS to teach MATHEMATICS to School Certificate standard, with some Elementary Physics or Geography, in the Technical High School attached to the College—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (February 17).

ENGINEERS (temporary) for the Public Works Department of the Government of Nigeria—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C 2 (quoting Reference No. E 1212.A) (February 20).

PSYCHOLOGISTS (two or more, temporary)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1 (February 21).

LECTURER IN BOTANY—The Secretary and Registrar, The University, Bristol (February 23)

ASSISTANT MASTER (full-time) to teach MECHANICAL ENGINEERING to Higher National Certificate standard and ALLIED SUBJECTS in the York Technical College—The Chief Education Officer, Education Offices, Clifford Street, York (February 24).

SENIOR LECTURER IN AERONAUTICS in the University of Sydney—Prof. A V. Stephens, c/o Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (March 1).

ENGINEER to take charge of all engineering and associated services in large old-established works in North Midlands area—The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No. C 2453.XA) (March 6).

LECTURER IN METALLURGY—The Registrar, King's College, Durham (March 10)

CHAIR OF ANATOMY in the University of Ceylon—The Secretary, Universities Bureau of the British Empire, c/o University College Gower Street, London, W.C.1 (March 19).

PROFESSOR OF PHILOSOPHY, tenable in the Durham Division of the University—The Registrar, University, 46 North Bailey, Durham (March 31).

ASSISTANT KEEPER to be responsible for the GEOLOGICAL COLLECTIONS in the Manchester Museum—The Registrar, The University, Manchester 13 (April 24).

LABORATORY ASSISTANT (skilled) FOR PHYSIOLOGY DEPARTMENT—The Vice-Dean, St Bartholomew's Hospital Medical College, at Queen's College, Cambridge

SECRETARY AND TECHNICAL EDITOR—The Secretary of the Technical Section, Paper Makers' Association, Melbourne House, Aldwych London, W C 2.

PSYCHOLOGIST (part-time) for the Child Guidance Clinic—The School Medical Officer, Public Health Department, Stour Street Canterbury.

RESEARCH ASSISTANT, with medical qualification, or degree in a biological subject, in the Department of Chemotherapy—The Laboratory Secretary, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool 3.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

London Shellac Research Bureau. Lac Derivatives as Substitute for Alkyd Resins By Dr. B. S Gidvani and N. R. Kamath. Pp. 8 (London: London Shellac Research Bureau, 1944) [24

Ministry of Health: Nurses Salaries Committee. Mental Nurse Sub-Committee Further Recommendations Mental Nurses S C Notes No. 1. Pp. 4 (London: H.M. Stationery Office, 1945. 1*d.* net [25

Parliamentary and Scientific Committee. Annual Report, 1944. Pp. 19. (London. Parliamentary and Scientific Committee, 1945.) [251

Catalogue

Books of All Ages. (Catalogue No. 674.) Pp 70. (London: Francis Edwards, Ltd, 1945.)

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SCIENCE IN THE FOREIGN SERVICE

THE departure of Prof. Eric Ashby for Moscow to take up his position as scientific attaché, with the rank of counsellor at the Australian Legation, to which he has been appointed, as recently announced (*Nature*, Jan. 20, p. 72), marks the first step in fulfilment of a proposal which has been increasingly discussed during the last two years. The interruption of communications by war conditions has of course made it necessary to improvise new organizations now that contacts of men of science are fewer and less easily arranged and even the publication of scientific and technical papers may require to be withheld temporarily or in part. Experience gained during the War with such organizations as the British Central Scientific Office in Washington, the American Scientific Office in London, the Anglo-Soviet Science Collaboration Committee, and the Scientific Co-operation Office of the British Council in China goes far to suggest that, even when normal means of communication and intercourse are fully restored, such organizations may still have a valuable part to play.

That much appears in the specific recommendations of the report of the British Commonwealth Science Committee, set up under the chairmanship of the President of the Royal Society in October 1941. Reporting in the summer of 1943, this Committee suggested the maintenance of permanent scientific and technical representation in London and possibly also in other capital cities of the English-speaking countries, in association so far as possible with representatives of the United States and others of the United Nations. This idea has since been further developed by Dr. J. Needham in his article on "An International Science Co-operation Service" (*Nature*, **154**, 657 ; 1944), where the further suggestion is put forward that the proposed Service should have permanent representatives in all countries and regions, with diplomatic or 'League-official' status, and guaranteed Government facilities for communication and transport.

This line of thought goes far beyond that of the mere exchange of information or even of personnel. As Dr. J. Needham has pointed out, the staff of a Science Co-operation Bureau in its work of collecting and disseminating scientific information must be familiar with the conditions of scientific and technical life and thought in the country where they are stationed. They must possess the confidence of the resident diplomatic personnel and be competent to advise them authoritatively on problems relating to science and technology. They must be unfailingly at the service of the Ministers of the Government departments concerned with science.

It is at this point, where the advantages of diplomatic status as suggested by Dr. Needham are most apparent, whatever its disadvantages in other respects, that we meet another trend of thought which has also thrown up the idea of scientific

attachés. Despite the welcome which the Government's proposals for the reform of the Foreign Service received generally in 1943, there was widespread agreement that they did not provide sufficiently for the introduction of a scientific outlook into the Service or the capacity to appreciate the importance of scientific and technical questions. Lacking that capacity or outlook, diplomatists cannot function effectively as intelligence officers in the modern world, and Sir Victor Wellesley, who recognizes clearly that essential function among various constructive proposals in his recent book "Diplomacy in Fetters" (Hutchinson and Co., Ltd., 1944), says that: "Scientific, industrial, and mineralogical attachés may soon have to be added". In a close survey of some aspects of the work of the Foreign Service, Political and Economic Planning in a broadsheet "The Future of Foreign Publicity" pointed out that an ambassador or minister is responsible for all the official contacts between his country and that in which he works, and he cannot escape a measure of concern for many of the unofficial contacts as well, since they may react upon the international relations which it is his primary duty to oversee and conduct. For this reason P E P believes that after the War the number and range of specialist officials may be increased, particularly in the general field of economics, and attachés to Embassy staffs for nutrition, agriculture and labour are particularly indicated, and possibly other attachés concerned with the Colonies or colonial policy.

The suggestion which Lord Samuel threw out in the House of Lords' debate on scientific and industrial research on July 15, 1943, regarding the appointment of scientific attachés to the principal British embassies abroad, or that Great Britain should be provided with scientific liaison officers competent to bring to the notice of those interested at home the progress and methods which have been achieved or established in other countries, thus fell on well-prepared soil. It has been taken up by the Parliamentary and Scientific Committee, which has prepared a confidential memorandum on the subject in the light of views obtained from various sources. The memorandum, after reviewing existing arrangements, recommends a formal inquiry into the whole question by the Government with representation of the Foreign Office, the Fighting Services, the Departments of Overseas Trade and of Scientific and Industrial Research and the British Council. The memorandum was adopted by the Committee on December 12, 1944, and has been sent to the Secretary of State for Foreign Affairs.

While this idea of scientific attachés has been widely discussed from both points of view, no practical steps have so far been taken in the matter, though Great Britain has an agricultural attaché in Washington. Among scientific men it appears to find widespread approval, for it is recognized that if the common attack on some of the scourges of mankind is to be organized effectively on international lines, in the way in which Prof. J. M. Mackintosh, for example, suggested in his review of preventive medicine at the recent British Association meeting, some further means of integrating knowledge and power will be required. At a recent dinner at which Prof. Ashby was present, the whole question was discussed and his appointment stimulated much favourable comment.

It has been left, however, to Australia to give a lead to the British Commonwealth and Empire in this matter, but Prof. Ashby's short visit to Britain will have convinced him that he carries with him the keen interest and the good wishes of scientific workers here. As already indicated, his appointment in Moscow is for about a year, and it should be clear from the note that has already appeared in *Nature* how well qualified Prof. Ashby is to act as a pioneer in a matter of close concern to the whole scientific world. Obviously a scientific attaché must be prepared to move across the frontiers of many different branches of science and to concern himself with the interdisciplinary questions involved in team-work and the corporate attack with different techniques on a common problem. Prof. Ashby aims at working in a laboratory for a time, but the U.S.S.R. and Australia have many problems in common, especially in agriculture and animal husbandry. By concentrating more or less on these problems at the start, Prof. Ashby may well find it easier to gain the experience and the sympathy and understanding which will assist the handling of more general and perhaps more delicate questions whether of co-operative research or the exchange of personnel.

This appointment is only a start, and it should be obvious that the appointment of scientific attachés can never be fully successful unless the traffic is in both directions. Prof. Ashby hopes that one result of his mission will be the visit of a Russian man of science to Australia, not as attaché, but to work in one of the laboratories and to study Australian science in general; he hopes also, if the U.S.S.R. approve, to arrange for an Australian man of science to pay a like visit to Russia. Whether in fact such interchange can be arranged remains to be seen, but Prof. Ashby can be assured that his work in Moscow will be closely and sympathetically followed by fellow men of science in Britain.

There can be no illusions as to the difficulties in this experiment or the demands it may make on Prof. Ashby's tact and scientific and organizing ability. Much may be learnt from it, but scientific workers in Great Britain will be at one not merely in wishing Prof. Ashby success but also in the hope that we will not be slow to follow the example and enterprise of the Commonwealth of Australia. Only if such steps are taken in the near future can we hope to be ready to organize effectively, on the world-wide scale demanded, for scientific and technical co-operation in the attack on the problems of the post-war world; and on the continuous application of scientific knowledge to problems of human welfare, on both of which the realization of a new world order of freedom from want, disease and fear depends.

MUCH ABOUT THE SOYBEAN

Soybean Chemistry and Technology

By Klare S. Markley and Warren H. Goss. Pp. viii+261. (Brooklyn, N.Y.: Chemical Publishing Co., Inc.; London: Macmillan and Co., Ltd., 1944.) 20*s*. net.

THAT versatile oriental bean, the soybean, has been a long time coming into its own among Anglo-Saxons. For many years it has been a staple product in China and Manchuria where, according to travellers' tales, all sorts of uses were made of it. After the War of 1914–18 it came to Britain in quantity, the beans having their oil 'solvent extracted', and uses were sought for the cake both as animal feed and as a source of protein for humans. A serious check was given to its use when cattle were injured by it owing to the presence of a poisonous glycoside. The oil was not too well liked by the soap-maker; it was not so 'soft', that is, unsaturated, as cotton seed oil, or hard enough to replace tallow, and the cost of hardening it by the catalytic process was not remunerative. Lastly, the growing of it was not understood either in Britain or in America.

During the last decade all this has abruptly changed, at least in the United States. It is stated that soybean now leads in the production of edible oil, having outstripped cotton seed oil, while the meal, as a superior protein ingredient for livestock and poultry food, has become of great utility. More important, soy flour in various forms is gaining in popularity: it is an ingredient of rations, included in bakery and other food products, and is sold direct to housewives. This latter applies to Great Britain also where soya flour, which we are beginning to learn how to use, has become a valued additional source of protein.

As protein shortage is one of the most serious deficiencies which ail the world of the future, the importance of the soya bean as an easily grown high-yielding source of it cannot be gainsaid. One question will be the nutritive value of this particular kind of protein, having regard to its constituent amino-acids.

There is thus considerable scope for a work on the chemistry and technology of soya, which this book seeks to provide: it is apparently sponsored by the Soybean Nutritional Research Council. Soybeans have fortunately proved to be a profitable crop in the corn belt of the United States; hence the willingness to extend their cultivation. During the last ten years, the acreage has increased tenfold, and the yield per acre has gone up by nearly 50 per cent; hence the production is almost fifteen times as great, the major extension taking place during the war years. A large amount of applied science has contributed to this result. There are many hundreds of types and strains, and the bean is peculiarly sensitive to changes in soil and climate; so that elaborate studies have been necessary to increase the yield and quality under local conditions.

The beans average 40 per cent of protein and 18 per cent of oil, with upper limits of 50 per cent and 24 per cent respectively. They are remarkable in being a rich source of the enzyme urease. The sugars include two of the rare ones, raffinose with 18 and stachyose with 24 carbon atoms. The glycosides comprise saponins, phytosterolins and *iso*flavone. The oil has about 2 per cent of phosphatides.

The first part of this book gives a useful summary of the chemical components of soy, and includes about five hundred references to the original literature. The second half deals in some detail with the processing mainly for oil, but contains also the most modern development of the production and refining of phosphatides. More than a hundred oil mills are listed as extracting the oil, an example of how quickly such an industry can be established. Soy flour is dealt with in a dozen lines only: it would appear that there is still much to do with it before it becomes a large-scale human food; one had expected to find much more under this head.

The book is probably mainly intended for practical use by those directly concerned with soybeans in one way or another, and as such is a model of what a really helpful text-book can be. It is easily written, concise and full of information not otherwise available.

There is no reason why Britain should not grow and process soybeans, provided a race can be found which fits in with the vagaries of our climate. Indeed, the Ministry of Agriculture ought to give direct encouragement to such work, for Britain just cannot afford to be left out of such modern progressive development. The day is definitely passed when we can be content to import the product of other men's enterprise and brains and stand still at home. If wool can be made from arachis protein, surely soya protein may prove an alternative source.

We can confidently recommend the book to those interested in the soybean. E. F. ARMSTRONG.

SINGING BREEZE

Wartime Harvest

Poems. By Marie Carmichael Stopes. Pp. 92. (London: Alexander Moring, Ltd., 1944.) 5*s*.

ALTHOUGH this choicely arranged volume of poems provides us with a further example of the author's versatility, I do not feel that Dr. Stopes is, as yet, sufficiently co-ordinated as a poet to be justly classified.

As Lord Alfred Douglas very rightly affirms in the preface to this collection—"adequate matter and form are here"—but despite this invaluable framework and a particularly fresh singing quality, there is often a falling-off of brushwork within the frame. "Instead of Tears", for example, dedicated to men who lost their lives on H.M.S. *Cossack*, containing as it does some of the finest lines in the volume, at the same time serves to illustrate the author's variability of treatment:

> "Brown berried sea-wrack tangles round your throat
> In festive chaplets where no fresh wreathed flowers
> Will reach you, and your resolute white limbs
> Are draped with laminarias crinkled strands."

A lovely stanza with an ease and flow of music possible only to the true poet, yet in the following stanzas we meet these all too familiar cliches: "this foul war"; "nightmare fiend"; "bright future full of happy toil". Surely a decline from the unobtrusive elegance of the quoted passage.

Thus we are borne along throughout the book in a series of such undulations between superb sweeps of melody, much admirable thought which, alas, often wilts into the banal.

I think, perhaps, the author's sustained lyrical vigour tends to obscure her critical faculty in this way. How else explain the inclusion of such verse as:

"You are
So far
I lie
And cry."

The strongest aspects of these poems are their directness of wording and vision, which make for easy reading; Dr. Stopes is never obscure, and whether it be a tribute to Homer or to a flower, she tackles her subject with fearlessness and generous sympathy. But in contrast one must again mention the admixture of quality, for there is an odd combination of highmindedness coupled with an almost youthful naivety of emotional expression discernible in these poems at times. One is reminded somewhat of the patriotic fervour prevalent at the beginning of this age.

Nowadays, the 'singing' poet needs to be very much on his guard lest he strike a note which is ineffectual rather than false when attempting to reflect current thought and feeling. The younger poets with their sober metre appear to manage this with more firmness of touch than can a transitional writer diffused between two vastly differing periods of time.

The shorter poems "To the Beloved", "If", "Judas" and "Ode to the South Wind"—this latter being an especially well-balanced work—all avoid pitfalls, and serve as admirable examples of the author's possibilities.

In summing up, I would describe this book of Dr. Stopes as 'interesting'; and with her many advantages of masterly style and appropriate imagery, she will no doubt eventually make the necessary adaptations to place herself within a more definable radius as a poet.

MARGARET HOWARD.

A SOUTH AFRICAN DIVINE RULER

The Realm of a Rain Queen

A Study of the Pattern of Lovedu Society. By Dr. E. Jensen Krige and J. D. Krige. (Published for the International Institute of African Languages and Cultures.) Pp. xvi+336+16 plates. (London, New York and Toronto: Oxford University Press, 1943.) 21*s*. net.

GENERAL SMUTS, in his foreword, commends this book as one of the most honest and penetrating researches into native life that he has come across. The tribute is well deserved. Dr. and Mrs. Krige selected a fascinating subject for study: the Lovedu, living among the mist-covered mountains of northern Transvaal. Insignificant as regards numbers and the extent of their territory, 33,000 tribesmen occupying a reserve of 150 square miles, their reputation was, and still is, great among the Bantu of South Africa; their queen was held to be the most powerful of all rain-makers, and even chiefs so distant and renowned as Chaka and Moshesh sought her aid in extremity. Many foreign ambassadors and potentates gathered at her court, bringing cattle or daughters or sisters to win the favour of "Transformer of the Clouds". To Europeans she was a mystery; was reputed to be very light-coloured (Was she really a white woman ?) and to be immortal. Rider Haggard familiarized her as "She-who-must-be-obeyed". There is substance in the fantasies that gathered about her. She figures as one of the Divine Rulers of whom Sir James Frazer has written.

In 140 years there have been three Lovedu queens, the present Mujaji III having reigned more than forty years. The first king was a scion of the famed Monomotapa, mighty monarch of the Vakaranga, whose sons divided the realm among themselves after his death. By incestuous union with her brother, the daughter of one of these chiefs bore a son and fled the country, carrying off the rain charms and sacred beads, and in course of time gathered about her a new community in the south, the Lovedu, of various origin. The queen is neither a military nor a political leader. She is not primarily a ruler but a rain-maker; what authority she exercises derives from her divine appointment and her exclusive power of controlling the rain, ensuring its fall for her friends and denying it to her enemies. The tribe relies for security not on regimentation, armies and organization, but on this power of the queen.

The rain-cult is a whole complex of institutions with ramifications through many aspects of tribal life. It is perhaps scarcely accurate to describe the queen as a rain-maker; she is so intimately connected with the forces of Nature that her life seems to be continuous with them; anything that affects her affects Nature. She is the guarantor of the cyclic regularity of the seasons; when she dies the seasons are out of joint. She has a monopoly of magic; anyone who should presume to enter into competition with her by practising garden magic would incur the penalties of witchcraft. There are certain limitations to her power: no one would expect her to produce rain in the winter; she relies upon diviners to diagnose the causes of drought; people can thwart her by certain infringements of taboo; and ultimately, it is recognized, her power depends upon the divine ancestors. Dr. and Mrs. Krige insist that belief in her virtue is universal and unshaken among the Lovedu—the Christians rationalize their belief by saying that she produces rain by the help of God.

How exactly the rain-queen exercises her power is a secret known only to herself, but it is known that certain 'medicines' are employed. These are kept in earthenware pots; Dr. and Mrs. Krige never saw these, but learnt that among the contents are one or more human skulls and the skins stripped from the bodies of deceased chiefs and councillors. A black sheep, said to be a substitute for a human child, is sacrificed from time to time to reinforce the medicines. The queen has no husband but many wives, some of whom, after a certain period, are allocated to nobles, and by this means a network is formed radiating from the queen all through the community.

One effect of having a queen of such divine authority is the elevation of the status of women in this patrilineal society. Lovedu tradition is that the king or queen never dies a natural death: he or she commits suicide, not when their natural vigour fails, but at the end of the fourth initiation during the reign, and these initiation ceremonies are held at intervals of from twelve to fifteen years.

Dr. and Mrs. Krige provide a very full exposition of the social organization and activities of these people. Having been challenged for a long period by Western civilization and having been percolated for much longer by various Bantu cultures, the Lovedu are a fruitful field for the study of culture contact and culture change; and the authors' findings on this subject are an important part of a very valuable contribution to social anthropology.

EDWIN W. SMITH.

APPLICATION OF INFRA-RED SPECTROSCOPY TO CHEMICAL PROBLEMS

IT was once said that in planning its discussions the Faraday Society does not follow scientific fashion and need, but anticipates them. This comment would apply well to the symposium held at King's College, London, on January 2, on the "Application of Infra-red Spectra to Chemical Problems". The large attendance of physicists and chemists from both university and industrial laboratories, as well as the diversity of subjects discussed, showed that this is a field of considerable interest and potentiality both for routine and research purposes in chemistry.

The striking advances in the experimental technique of infra-red measurements during the past ten years were described in a joint comprehensive paper from the laboratories at Oxford and Cambridge, where Drs. H. W. Thompson and G. B B. M. Sutherland with their colleagues have vigorously explored all aspects of the problem. As Sir Robert Robertson remarked, it is not many years since the difficulties of obtaining stable thermo-electric systems for the accurate measurement of infra-red radiation made it necessary to work at night, and the exacting conditions were magnified, since many hours or weeks might be needed to cover a significant spectral range. Recent developments of prism spectrometers have been mainly directed towards greater speed of measurement, stabler and more sensitive detectors, and automatic recording of the spectral absorption. By incorporating new vacuum thermocouples of rapid response and high sensitivity, automatic continuously recording instruments have been developed which can be used in routine laboratories without elaborate experimental precautions or difficulty.

Single-beam recorders, however, suffer from the disadvantage that atmospheric water vapour and carbon dioxide give rise to an irregular background, which complicates the determination of percentage absorption in some spectral regions. The most recent refinement is to use a double-beam spectrometer, in which the energy of a blank beam of radiation is measured against that of a similar beam into which the absorbing substance has been placed. The two beams are focused separately on thermocouples, and the electromotive forces produced are fed, after amplification, into a quick-acting potentiometer recorder having a rapid speed of response. In this way the absorption spectrum can be obtained as a direct record of percentage absorption—or if required optical density—against wave-length, so that the arrangement becomes entirely automatic. While this type of instrument surpasses the hopes of a few years ago, still further improvements may eventually result from the use of bolometers.

Interesting exploratory work on a thermocouple-bolometer detector was described by Dr. G. K. T. Conn. Another noteworthy feature is the production, by cooling the molten solids, of large blocks of alkali halides having high optical quality and suitable for use as prisms.

Apart from the spectrometers themselves, development of the accessories has been marked. A convenient absorption cell for studying molten solids was described by R. E. Richards and Dr. H. W. Thompson, and several speakers outlined methods for the accurate determination of the thickness of such cells. The most favoured methods are based on interference phenomena using either infra-red, visible, or ultra-violet light, and examples were given by Dr. G. B B. M. Sutherland, H. A. Willis and by Dr. W C. Price For many purposes, infra-red spectra of substances have to be measured in solution, and the solvent will have its own absorption bands which may mask those of the solute In order to survey the spectrum of a given solute over a wide spectral range, it will therefore be necessary to use several solvents. P. Torkington and Dr. H. W. Thompson set out the spectral transmission curves of a large number of common solvents, which should serve as a useful reference in selecting the most convenient one for use for any particular spectral region.

Turning to the applications themselves, the infra-red absorption spectrum emerges as another physico-chemical tool for analysis in organic chemistry. This is perhaps the most significant general contribution from recent progress. Absorption bands arise from the absorption of molecular vibration frequencies the magnitudes of which depend upon the nuclear masses and the forces between them Since no two molecules, other than a pair of optical isomers, have exactly the same nuclear structure and potential energy function, the vibrational spectrum will be a characteristic property of the molecule, and perhaps the most characteristic yet known. Drs. H. W. Thompson and G. B. B. M. Sutherland reviewed the principles by means of which these theoretical considerations can be applied to the practical problem of analysis, and examples of mixtures studied by their collaborators were given. A very striking case is the analysis of mixtures of the three isomeric cresols, which can be carried out rapidly with fairly high accuracy; but from the varied assortment of examples given it was clear that the method can be used generally. It is very useful for determining small amounts of impurity in reagents, fine chemicals, solvents and important compounds of biological and pharmaceutical interest. Dr. Thompson mentioned a case in which a crude solid product containing four stereoisomers could be analysed with comparative ease in about half an hour. The factors which determine the sensitivity for detecting a particular component, and the accuracy obtainable in analysing a mixture, were discussed. As foreshadowed in his Tilden Lecture to the Chemical Society last year[1], it seems certain that infra-red analysis will soon become a standard method for the control of purity of organic substances.

Other applications of the infra-red are mostly connected with the elucidation of molecular structure; but whereas past work has dealt almost exclusively with smaller molecules, the absorption bands of which could be resolved into rotational fine structure from which moments of inertia might be determinable, measurements have now been made with macro-molecules, and a wealth of information has been derived from them. Examples of many kinds were discussed. Thus, Dr. D. M. Simpson examined critically the infra-red data on ozone in relation to electron diffraction measurements, and tried to obtain an assignment of the normal vibration frequencies which is consistent with the spectral data, and which simultaneously gives plausible values for the apical angle and bond force constants on the basis of simple valency force field. As the author explained, the arguments and results obtained are not free from objection, and suggest that a more detailed analysis of the rotational fine structure of the infra-red and Raman bands should be carried

out; at the same time the way in which all the evidence has been correlated and examined provides a good example of this class of work.

In another paper dealing with the force fields within molecules, Dr. J. W. Linnett reported calculations on the variation of the force constants of C—H, N—H, O—H, S—H and other M—H bonds in series of molecules. The characteristic vibration frequency of such linkages is always much higher than those of other normal vibrations, since for practical purposes the light hydrogen atom oscillates against a much heavier effectively rigid residue. By virtue of this, it is possible to use simple formulæ for calculating the force constants of these links and still obtain results which must approximate closely to the true values. In this way Dr. Linnett has made a valuable compilation of the C—H force constants as affected by adjacent groups. In methyl fluoride the value is low as compared with methane, whereas in the other methyl halides it is normal. In methylamine and methyl alcohol, and even in ethane too, low values are found, and these are very well explained in terms of the contribution of different ionic structures towards a resonance hybrid. Dr. Linnett's analysis of the data shows that other factors affecting the force constants are the type of carbon bond orbitals used, namely, sp^3, sp^2 or sp, and the extent to which there is a positive charge located on the carbon atom. Analogous computations were made for the other M—H bonds, and the whole work should be of great value for future reference.

How the rotational contour of absorption bands of the vapours of relatively light molecules can be used with other data to determine the fundamental frequencies of a molecule was illustrated with reference to fluorinated ethylenes by P. Torkington and Dr. H. W. Thompson. A comparison of the vibration frequencies of vinyl fluoride with those of the other vinyl halides revealed unexpected peculiarities. The presence of the fluorine atom brings about a marked decrease in the values of the deformational frequencies of the C—H bonds at the other end of the molecule, whereas with the light fluorine atom the reverse might be expected. Similar effects are found with vinylidene fluoride, $CH_2 : CF_2$, and with $CH_2 : CFCl$. We can interpret these changes as arising from some electronic effect transmitted through the carbon-carbon double bond, or as Dr. Price put it, in terms of the contributions of ionic structures towards the molecular resonance hybrid. Related to this, too, are the alterations found in the C=C vibration frequency in the different compounds, for in passing from ethylene to vinyl fluoride there is a small increase, and when two fluorine atoms are attached to the same carbon atom, as in vinylidene fluoride or tetrafluoroethylene, it is even higher. Another feature is the very high intensity of absorption of vibrations due to stretching of C—F bonds, particularly when CF_2 groups are present, and this must again be connected with the variations of polar character of the linkages during compression. These data open up a new line of inquiry into the reasons for the well-known anomalous chemical and physical properties of compounds containing carbon-fluorine bonds.

With macro-molecules such as rubbers, plastics, and resins, which are nearly always examined in the solid state, the infra-red spectra consist of bands arising from absorption of the fundamental vibration frequencies, or overtones or combinations of them, and this is the only information about the molecule which the spectrum gives. It is therefore remarkable to find that a considerable amount of information about the structure of these molecules has already been derived. Dr. Thompson presented an extensive survey of the spectra of many classes of compound of high molecular weight studied with his collaborators during recent years, and illustrated by selected examples the sort of questions which can be answered by this approach. The primary aim of the work is to correlate internal molecular structure and the mode of packing of large molecules with their physical behaviour, particularly in regard to flow and electrical characteristics. The main principle is that while the complete spectra of two molecules should never be exactly the same, yet particular links, groups, or skeleton units may have a frequency or set of frequencies which persist almost unchanged through a large number of molecules in which they occur. If reference data on simple molecules are first obtained, it will then be possible to detect or estimate such groups, and if enough data of this kind are available, crucial information about the macro-molecule may be inferred.

Polythene, originally thought to contain a long chain of CH_2 groups, is found to contain a few pendent methyl groups, and weaker bands can be correlated with other unexpected units in the nuclear skeleton. When dienes such as 1 3 butadiene, or 2·3 dimethyl butadiene, polymerize to form the different varieties of rubber, 1·4 addition may occur leading to long 'straight' chains such as

$$—CH_2—CH{=}CH—CH_2—CH_2—CH{=}CH—CH_2—;$$

or 1·2 addition which results in pendent vinyl groups,

$$\begin{array}{cccc} —CH_2— & CH & —CH_2— & CH— \\ & | & & | \\ & CH & & CH \\ & \| & & \| \\ & CH_2 & & CH_2 \end{array}$$

The amount of branching in a long-chain polymer of this kind is known to have a profound effect on properties such as ease of vulcanization or use as a lubricant. Chemical methods involving ozonolysis were worked out by Simonsen and others some years ago; but the infra-red method is both quicker and neater. It depends on the fact that different classes of olefines have spectral features which are characteristic for each type. There are key wave-lengths for (1) the vinyl compounds $R.CH : CH_2$, (2) the substituted *iso*butylenes $R_1R_2C : CH_2$, and (3) the *cis-trans* olefines $R_1CH : CH.R_2$, and estimates of the amount of each type can be made from measurements of the absorption intensity at the key wave-lengths. These principles were illustrated with reference to samples of buna and methyl rubber, and analogous correlations with other hydrocarbon polymers such as crepe rubber and polystyrene were outlined. The determination of 1·2 or 1·4 addition applies in a similar way to the interpolymerization of butadiene with acrylonitrile or styrene. In such cases, too, the proportions of the components in the interpolymer can be estimated, and minor changes in the structure of an interpolymer as the combining ratio changes can be explored by changes in the infra-red spectrum.

Another class of polymer discussed by Thompson and Torkington included the polyvinyl and polyacrylic esters, and the spectra of some of these compounds were considered in relation to such features as head to head or head to tail condensation. A comparison of the spectra of polyvinyl chloride, polyvinylidene chloride, and those of halothenes (chlorinated polythenes) seemed particularly interesting. As the percentage of chlorine introduced into the polymer

is increased, well-defined changes in the spectrum occur, and it may be possible to discover how the chlorine atoms are distributed along the long carbon chain. It is noteworthy that the spectra of polyvinyl chloride and polyvinylidene chloride differ from those of halothenes containing the same percentage of chlorine. Other compounds studied include polyvinyl alcohol, nylon, polyester waxes and novolac resins, and in each case structural features of value are obtained. Cellulose ethers and esters have also been examined, and in structural diagnosis the new method promises here to be an important supplement to X-ray work, while for practical purposes the identification and estimation of hydroxyl groups, aceto or butyro groups should be valuable.

Other general matters discussed by Thompson and Torkington included the differentiation of a polymer and its monomer, and the possibility of correlating spectrum with chain-length, and attention was also directed to the use of polarized infra-red radiation with oriented films of certain polymers.

Dr. Sutherland mentioned similar work on polymers carried out with Mr. Ramsay and Mr. Harding. Differences had been found between certain samples of polystyrene and of poly-*iso*prenes, and structural inferences had been made.

N. Sheppard and Dr. G. B. B. M. Sutherland described measurements on the spectrum of rubber after vulcanization and 'curing' by various reagents. The changes which occur during these processes can be followed by changes in the spectrum. Thus, if zinc oxide and stearic acid are used in the curing process, a band appears in the spectrum due to the stearate ion, which disappears again as the vulcanization proceeds. It is interesting also to find that, in the early stages of vulcanization at least, the band due to the carbon-carbon double bond in crepe rubber remains almost unchanged in intensity. The latter result was confirmed by Dr. Thompson in some similar studies in which rubber was treated with sulphur chloride vapour for different periods. In this case new bands were found in the spectrum which may be connected with sulphur-sulphur or carbon-sulphur linkages, and comparisons are required with the spectra of simple alkyl sulphides and disulphides.

Mr. C. G. Cannon discussed measurements on the infra-red spectrum of coal and coal extracts, and showed how various important groups may be identified in the samples. Although this work is so far exploratory in character, it indicates already that a new attack is possible on the differences between coals of varied origin.

Mr. H. A. Willis outlined similar measurements carried out with Dr. Sutherland on the infra-red spectrum of diamond, a subject investigated some years ago by Sir Robert Robertson and the late Sir John Fox. The new measurements suggest that another type of diamond has been found, and the authors stated that Sir C. V. Raman and his colleagues have recently misinterpreted Raman data. In the discussion, Sir Robert Robertson directed attention to the errors in measurement of the intensity of absorption bands which may be caused by scattering losses. Whatever the real explanation, it is clear that further measurements of this kind may lead to important knowledge about the different kinds of diamond.

The Faraday Society is to be congratulated on organizing this stimulating discussion.

[1] *J. Chem Soc*, 183 (1944).

GORDON COLLEGE AT KHARTOUM

UNIVERSITY COLLEGE STATUS

By E. N. CORBYN

Former Principal of the College

A FORMAL inaugural opening of the reconstituted Gordon Memorial College at Khartoum will take place on February 20.

When in 1898 Lord Kitchener had won the battle of Omdurman, which opened the Sudan to civilization, and then went home to receive the thanks of his grateful fellow-countrymen, his first action was to ask for and receive from them by public subscription £100,000 for the building and endowment of a college at Khartoum in memory of General Gordon, for the education of the Sudanese.

In 1902 his return from the South African war gave him the opportunity to open the fine buildings erected on the bank of the Blue Nile, not far from the Palace where Gordon died. Those whom he had left behind in the Sudan, General Sir Reginald Wingate, his successor as governor-general, his young brother-officers of the Royal Engineers who had taken charge of the new country's public works, Mr. (later Sir) James Currie, whom Lord Cromer had chosen as the first director of education, all had laboured to carry out the beginnings of his intention. What was his ultimate purpose he placed on record at the opening ceremony, when he said: "All I hope and trust is that it may be round this centre that development of higher education in the Sudan may be focused for all time".

The site allotted for the Gordon College was one of the best on the Khartoum river-front, and by far the most extensive It covers many acres and includes, besides space for the buildings, ten football grounds intersected by avenues of shady trees. Its eastern boundary lies close to the Blue Nile Bridge, and along the road and railway embankment that makes a wide circular sweep round to the railway station behind the city of Khartoum. The main building, with a central block and two wings, is a large and impressive structure, the design making use of wide and lofty verandas, suitable to provide shade from the violence of the tropical sun. Inland from the playing-fields are large boarding-houses, and the grounds contain also other educational buildings and staff houses.

Currie's task, as the first director of education in the Sudan, was to inspire with the breath of life the bricks and mortar which Kitchener had provided. This he had to do by bringing into the Sudan an adapted blend of Western and Arab education. He had seen the blend as approved in Egypt during a short period of service under Dr. Douglas Dunlop in the Egyptian Ministry of Education, which had enabled him to form his own ideas. In the *tabula rasa* of the Sudan, where he arrived in 1900, his opportunity was unique, and nobly he took it.

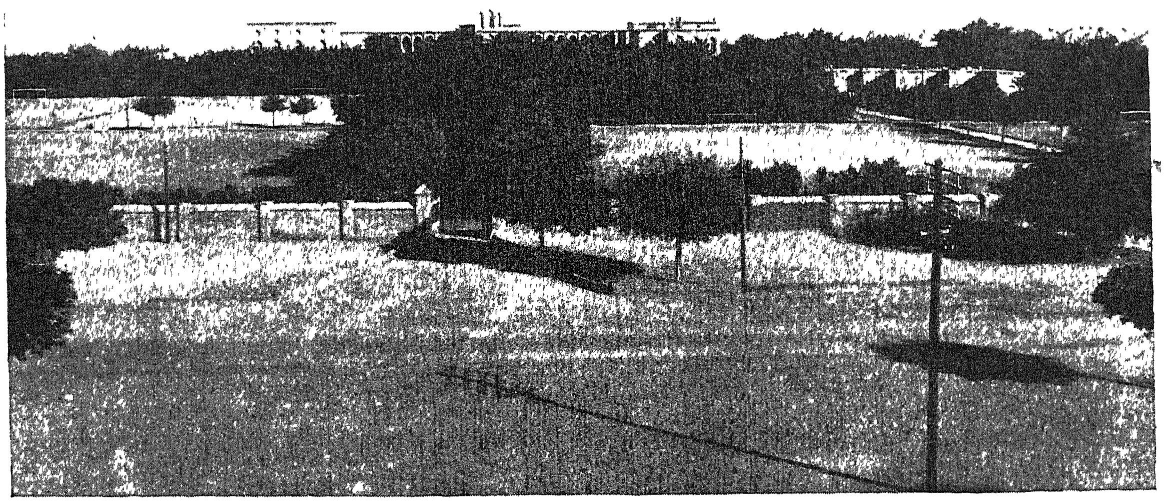
It was Currie's view that, at all events in the early formative years, the director of education should be also the principal of the Gordon College. He held that thus the College could best be integrated with the general educational machinery of the country, which also he was devising and installing, so he was insistent on presiding over both.

Even when, in its beginnings, to the ordinary man the College seemed to consist of a few Sudanese boys

being taught by (at first) Egyptian teachers to become the future teachers of their fellow-countrymen (for so, of course, it had to start), Currie, with the eye of faith and imagination, saw it already as in part a university He held that, if one side of his duties was to commence imparting instruction at the lowest level, another side was to have in the same buildings working examples of human knowledge at its highest level. So he gathered into his College all those branches of scientific research so necessary in a new land, but which, to be successful, must work in a congenial home. The new Government needed medical research, chemical research, entomological research, geological research Currie opened to all of

Carter, was in process of establishing. These were to deal with matters of the personal law of the Sudanese (marriage, divorce, inheritance, etc), who in the Arabic-speaking parts of the country are almost universally Mohammedans Soon learned Sheikhs from the ancient University of El Azhar in Cairo were teaching promising classes in the study of their own religious law. The religious law courts of the Sudan have thus come now to be presided over by Sudanese 'Kadis', or judges.

At the lower levels the College housed at first what had to begin as education of the primary school stage This developed into secondary school education, with vocational courses in the latter stages for



THE GORDON MEMORIAL COLLEGE FROM THE SOUTH (INLAND) SIDE, SHOWING PLAYING-FIELDS AND THE BLUE NILE BRIDGE IN RIGHT BACKGROUND

them his arms and his buildings. He grouped them under him as principal of an institution in which research of highest university standard could work and flourish. This was only not a university because its brilliant staffs were there to do their own work on the problems of the country, and not, at that stage, to teach or give diplomas or degrees.

Such was Currie's conception. It was not always understood, even by fellow-workers in different spheres of the Sudan's administration. But what mattered was that he had brought it to birth and it existed, and it made the Gordon memorial buildings on the Blue Nile a centre of light and learning from the very start of the great enterprise for which they had been designed.

Meanwhile the early stages of education for the Sudanese went steadily forward. Currie was quick to seize on one indigenous branch as already of university standard—the study of Mohammedan law for the staffing of the Mohammedan law courts which the first Legal Secretary, Mr. (later Sir) Edgar Bonham

engineers, teachers, and clerical Government staff. When the numbers in the secondary school grew so as to fill the buildings, the primary school was extruded and became the Khartoum primary school, housed elsewhere. Similarly, other primary schools were established in the other larger towns of the country, and became feeders for the secondary school in the Gordon College. This was often spoken of as though it alone was the Gordon College; but, as will have been seen from the details given above, the College was much more

Such was Currie's Gordon College when he retired, in 1914, and in essence it remained the same under his immediate successors. I was myself the third principal and director of education during 1926–27. My own suggestion for the next stage was to extrude the junior two years of the secondary school, by developing the four-year-course primary schools which fed it into six-year-course intermediate schools, and then to add two more senior years to the secondary school course, thus taking it two years further on

into higher education Changes remained in abeyance, however, until the whole Sudanese system of education was considered and reported on in 1937 by the De La Warr Commission. This Commission went further and recommended the extrusion of the whole four years of the secondary school course, and the transfer of the secondary school or schools elsewhere; so that the way might be clear at the Gordon College for the establishment of education at a post-secondary, or university college, stage.

Such was the programme which Mr Christopher Cox, the sixth principal, taking up the De La Warr Commission's recommendations with admirable zeal and skill, was able to lay before the Sudan Government. In spite of the impact of the War on the country's finances, the Government decided to carry it out. The design included two (at first) secondary schools, placed in different parts of the country outside Khartoum, to which the secondary school in the Gordon College would be transferred. The buildings for the first of these, at Wadi Seidna on the Nile north of Khartoum, were just being completed as the War began These buildings and the buildings of the Gordon College itself had then to be requisitioned for military purposes. The secondary school, instead of going to Wadi Seidna, had to find temporary accommodation opposite Khartoum in the big native city of Omdurman, where it still remains until Wadi Seidna is free for its occupation.

The Gordon College buildings were released in 1944, thus removing the structural bar on the constitution of the new University College, the plans for which now took final shape The early vocational courses had been developed into schools for education at a professional level. It was the grouping of these schools that was designed to constitute the University College.

In November 1944 there took place at Khartoum the first formal meetings of a Council set up to administer the College in that capacity. This Council becomes the authorized delegate for that purpose of the Executive Committee of the Gordon Memorial College in London, under powers given to that Committee by the trust deed made when Lord Kitchener collected the endowment.

Included in the new College are six post-secondary schools—the School of Arts (which includes a School of Law), the School of Science, the School of Engineering, the School of Agriculture, the Khartoum Veterinary School, and the School of Administration and Police. This new united body of post-secondary schools now takes over the name, the buildings and the endowments of the Gordon Memorial College.

The reconstituted College will still leave outside its present framework two Sudanese educational institutions of post-secondary rank, the Kitchener School of Medicine at Khartoum, and the Institute of Education at Bakht er Ruda, which is in a rural setting on the White Nile about 120 miles south of Khartoum. The Kitchener School of Medicine, founded in 1924, though linked also with the Executive Committee of the Gordon Memorial College in London, has endowments subscribed in the Sudan and a constitution of its own. In addition to the income of its own endowments, it receives an annual subvention of a thousand guineas from the Lord Kitchener National Memorial Fund in London. The Institute of Education is established and administered by the Sudan Education Department. Both will be brought into organic relationship with the new University College in due course.

The College now, as a university college, will have a principal of its own, other than the director of education, and Dr. J. D. Tothill, recently director of agriculture and forests in the Sudan, has been nominated as the first holder of that post. The constitution devised for the College on university lines gives to its Council a large measure of independence from the Sudan Government. It is the Government's desire and purpose to grant to it, as soon as the money can be made available, ample endowments of its own, for which a figure of £3,000,000 is aimed at.

It remains to give some brief account of the details of the Schools of the College, which branch respectively from the School of Science and the School of Arts.

The School of Science has preparatory courses for the Kitchener School of Medicine, the Veterinary School, the School of Agriculture, the School of Engineering, and for teachers of science going to the Institute of Education. In 1945 it will commence also a three-year diploma course of its own.

The School of Medicine has a six-year diploma course, the School of Engineering a four-year one, and the Veterinary School and the School of Agriculture grant their diplomas after three years.

The School of Arts has a four-year diploma course in law, and three-year diploma courses in history, English, Arabic and geography. A two-year course is the condition for entry to the arts teachers' section of the Institute of Education, or to the School of Administration and Police, or to certain government employments

Members of the new Gordon College inherit the fine hostels and beautiful playing-fields established in the past. These fortunate young Sudanese will have at their disposal all that is necessary for the building up of healthy minds in healthy bodies. The educational history of the Sudan in the past forty-five years leaves little doubt that they will rise to their opportunities.

THE PEATS OF NEW JERSEY

TWO recently published bulletins[1] provide a broad picture of the peat bogs of New Jersey. If these are read in conjunction with other publications[2], one is given a wide purview of American east-coast peat bogs from Maine to Florida. In these various bulletins there is in particular very detailed information about the maritime peats, both the salt marsh and the mangrove types. One is chiefly impressed, however, by the scale upon which this study of the New Jersey peats was carried out. The investigation was treated as an official Work Projects Administration project, and fifteen to twenty-five field-crews of five men each were engaged upon it in addition to office and laboratory staff, so that the total number employed was at one period about 150 persons. There is still scope for investigations on this scale in the British Isles, and it is to be hoped that the end of the War may see similar projects in being. In particular, British peat bogs or salt marshes would be eminently suited to this type of treatment, and in view of the possible value or use of such land for agricultural purposes there would seem to be a strong case for Government support of any such research programme on a commensurate scale.

The first bulletin is introductory in nature, and provides a general survey of peat as a whole. The

terminology associated with peat is discussed in some detail, especially the use of the word 'muck', which is employed for certain important agricultural soils in the United States. This word appears to have two meanings; in one case it refers to a mixture of decomposed peat and mineral soil, while in the other case it is used commercially for non-acid or low-moor peat. Four classes of peat are recognized (*a*) hochmoor, (*b*) lowmoor (including salt marsh peats), (*c*) swamp or forest peat, and (*d*) aquatic or alluvial peats, though these latter contain such a high percentage of sedimentary material that their claim to be termed peat may be questioned. In discussing the factors influencing peat formation, insufficient attention has perhaps been paid to correlations between pollen analysis and the historical development of the region. Godwin and his co-workers in Great Britain have shown how much can be achieved in this direction. The pollen diagrams are indeed inadequate and disappointing, and it is to be hoped that a further bulletin may be devoted to this important aspect. It must, however, be admitted that the survey was largely undertaken with the agricultural possibilities of the peat soils as the pervading background. Similarly, in discussing the microbiology of the peats, there is little or no mention of the part played by the mycorrhiza which are associated with many bog plants.

While the first bulletin contains much information that is of great value, it is largely a summary of existing information as applied to New Jersey peat bogs. The second and more substantial bulletin gives an account of the actual results obtained by the field parties and the laboratory analysts. This information is given in considerable detail, and after perusing it we are left with an extensive picture of the characteristics of the principal areas and peat bogs throughout the State.

Hochmoor or blanket bog peat is practically unknown in the State, and there are very few bogs composed of sphagna remains Out of 91–114 million acres of peat bogs in the United States, the State of New Jersey claims about 500,000 acres. In the areas surveyed the proportions of the different types were more or less as follows: lowmoor or fen peat, 20,961 acres; salt marsh peat, 100,725 acres; swamp or forest peat, 56,241 acres; fresh water alluvial peat, 28,357 acres. Topographically, New Jersey can be divided into four regions, the Appalachian Valley, the Highlands, the Piedmont plateaux and the Coastal Plain. In the lower part of the Appalachian Valley the bogs frequently rest on Kittatinny limestone and they differ from those elsewhere due to the influence of this substratum. It can also be shown that many of the bogs have developed in depressions associated with the terminal moraine of the Wisconsin ice-sheet; but there are others, especially smaller bogs, which are associated with the numerous 'Kame' moraines.

The pollen analysis diagrams indicate that peat formation commenced in the boreal period. This was followed first by a *Pinus* era and then by oak and hemlock. For purposes of description, the State is divided into twenty-one drainage areas each with its own system of bogs. These bogs formed approximately 60 per cent of the areas surveyed, and the average size of a bog was about 9,800 acres, but they ranged from 241 to 35,711 acres.

The northern peat bogs are all of the lowmoor or fen type, though one large forest (cedar) swamp is described from the Hackensack region. *Carex* is the principal peat-forming plant in these bogs at the present day, but the numerous sections through the bogs show that two general types of deposition have occurred. In one case there is a sedimentary layer at the base, while in the other there is a shell marl from a relict *Chara* phase. On these basal layers there is commonly a *Phragmites* peat followed by a *Carex* peat with a further zone of decomposed *Carex* peat on top. The *Phragmites* and non-decomposed *Carex* layers may contain the remains of tree stumps.

The other three types of peat bog are primarily confined to the coastal plain region. Some of these peat bogs are of very considerable size; for example, the great cedar swamp six miles long and two miles wide at its broadest, and the salt marsh peat area at Great Egg Harbor thirteen miles long and six miles wide. The salt marsh peats have average depths of 3·4–15 ft with maximum depths of 16–34 ft. The maximum tidal ranges along this stretch of coast, as given by the U S. Coast and Geodetic Survey, vary from 1 ft to 6 ft.; since the depth of the peat commonly exceeds the maximum tidal range, subsidence of the coastline must have taken place during the formation of many of the marshes[3]. These salt marsh peats usually possess three well-defined zones: a basal *Zostera* zone, a middle *Spartina glabra* zone and an upper *S. patens* zone In spite of continual flooding by salt water it was found that the peats tended to have an acid reaction, said to be due to the reduction of sulphates to sulphides by bacteria. This is in distinct contrast to the alkaline peats of the southern mangrove swamps of Florida and the West Indies. If this is indeed true, one may question whether the salt marsh peats should be classified with the lowmoor or the fen peats, as is suggested in the first bulletin.

The freshwater alluvial peats are mainly restricted to the Lower Delaware basin, and are found north and west of a line joining Asbury Park, Colts Neck, Farmingdale, Clarksburg, New Lisbon, Berlin, Malaga, Millville, Delmont and South Dennis. While the salt marsh peats are a prominent feature of the coastal plain region, the forest peat swamps of the New Jersey pine barrens are of equal importance. Two types of forest peat bog can be distinguished: there is first the cedar swamp type with *Chamæcyparis thuyoides* as the dominant tree and, secondly, the deciduous swamp type with pitch pine and white oak as the dominants. The profiles of the bogs show that whole regions of the coastal plain have been covered in the past with forests of white cedar and that these forests have been submerged by the sea, have then emerged and been submerged again. Many of the forest swamps are juxtaposed to tidal marshes which in their turn generally lie behind protective barrier beaches. The balance between the forest swamps and the tidal marshes is delicate, and one passes readily to the other or vice versa, depending on the upward or downward movement of mean sea-level. Sufficient data should now be available to make it possible to determine whether such sea-level movement is in fact taking place at present. The forest peat is underlain either by sand or by sedge and reed peat or by *Carex* peat, the lower layers often containing numerous tree stumps.

This second bulletin is profusely illustrated with profiles across bogs of all types from the many different regions and with the relevant analytical soil data. It is to be hoped that the latter, which are not as extensive as one could wish, will be augmented in a further bulletin. There is no doubt that

the organization and scope of this study should prove a model upon which investigations in other parts of the world might well be based.

V. J. CHAPMAN.

[1] Waksman, S A, Bull 55 Part A Dept of Conservation and Development, New Jersey (1942) Waksman, S A, Schulhoff, H, Hickman, C A, Cordon, T C, and Stevens, S C, Bull 55, Part B, Dept of Conservation and Development, New Jersey (1943)

[2] Shaler, N S, Ann Rep U S Geol Survey I (1884–5) Davis, J H, State of Florida Dept of Conservation, Bull 25 (1943) Johnson, D W, "The New England Acadian Shore-line" (New York, 1925)

[3] Chapman V J *Proc Geol Assoc* **49**, 373 (1938)

OBITUARIES

Sir Thomas Barlow, Bt, K.C.V.O., F.R.S.

THOMAS BARLOW, who died in London on January 12, was within eight months of his hundredth birthday, which he would have well liked to see Brought up in the cotton belt of Lancashire, in a household where character—rough hewn but solid—was the ruling factor, he was endowed with a good memory and a power of observation that has made famous naturalists, and his span covered a century in which medicine has progressed geometrically If the wattage of life may be taken as a multiple of duration, brilliance and worth, no wonder Barlow has left a mark on his contemporaries. His middle period as popular consultant and physician to three reigning sovereigns—Robert Bridges said he knew no medical man with a more intimate personal sympathy with his patients—was preceded by a period in which he traced a common childish disorder to its origin as a deficiency disease, and was succeeded by an Indian summer in which he used his experience and still abounding energy to guide a benevolent fund which gave a sense of security to the declining days of less successful practitioners.

The early period is the one which deserves elaboration here. In 1874, when Barlow became registrar to the Hospital for Sick Children in Great Ormond Street, the hand-feeding of infants had taken a turn towards artificial foods and sterilized milk, with the result that what was called 'acute rickets' began to come to the notice of clinicians. Barlow's colleague, W B. Cheadle (following Ingerslev in Sweden), suggested that here was scurvy grafted on the familiar tokens of rickets; but when Barlow came to make his classical study of thirty cases, published in 1883, it was evident rather that here was a clear-cut deficiency disease, namely, infantile scurvy, due simply to exclusion from the diet of something essential to healthy growth and development. It took another fifty years for the nature of scurvy to become generally recognized and the appropriate vitamin supplied But for the first step which counts so highly, Barlow earned his election to the Royal Society in 1909 and the less glittering reward of having the disease he had described known abroad as *die barlow'sche Krankheit.* E. C. M.

WE regret to announce the following deaths:

Dr. G. D. Elsdon, chief inspector of the Lancashire Rivers Board and formerly chief county analyst for Lancashire, on January 18, aged fifty-six.

Prof. C. B. Lipman, professor of plant physiology in the University of California, on October 22, aged sixty-one.

NEWS and VIEWS

Galton Chair of Eugenics at University College, London: Dr. L. S. Penrose

DR L. S PENROSE, who has just been appointed to the Galton chair of eugenics at University College, London, studied philosophy at Cambridge and proceeded to Vienna in 1923 for postgraduate work in psychology. On returning to England he took a medical degree, and during 1930–39 was research medical officer to the Royal Eastern Counties Institution at Colchester. His report on 1,280 mental defectives and 28,921 of their relatives has put the whole problem of mental defect on a new basis. Congenital mental defect may be due to single dominant genes such as that for epiloia, to single recessive genes such as that for phenylketonuria, or to numerous partially dominant genes, in which case it is inherited like other quantitative characters studied by Pearson There are probably hundreds of types, each ultimately distinguishable clinically, with its characteristic mode of inheritance He has paid particular attention to pre-natal environment in connexion with mongolism, placenta prævia and pyloric stenosis, and was the first to estimate the mutation-rate of an autosomal human gene. Since 1939 he has worked in London, Ontario, particularly on the genetics of insanity and on personnel tests for the Canadian Army.

Pearson and Fisher, the first occupants of the Galton chair, came to eugenics from mathematics, via statistics; Prof. Penrose comes from psychology via medicine If his views are accepted, the eugenic movement will become a good deal more concrete. It may be no more possible to wipe out mental defect than to abolish fever; but appropriate eugenic measures might reduce certain types of defect as drastically as hygiene has reduced typhoid fever, while other types would not be reduced. Prof. Penrose will use the statistical methods developed by his predecessors, but he will use them on data which have been provided by up-to-date clinical and psychological methods.

Botany at University College, Nottingham

DR. C. G. C. CHESTERS has been recently appointed to the chair of botany at University College, Nottingham, in succession to Prof. T. A. Bennet-Clark. Prof. Chesters graduated in the University of Glasgow where he received his botanical training under the leadership of Prof. Bower and took up an appointment at Birmingham in 1927. From 1930 onwards, when he became lecturer, his energies were devoted mainly to the study of mycology, and he became reader in mycology in 1942. During this period, Prof. Chesters built up a flourishing school of mycological research. His chief mycological interests have been in the Pyrenomycetes and Phycomycetes. His work on British Pyrenomycetes, published in a series of papers from 1935 onwards, must rank as an important contribution to the study of the life-histories and taxonomy of the group and he is justly recognized as an authority in this field. More recently, Prof. Chesters has been experimenting with new methods of approach to the difficult problem of the study of the fungus flora of the soil, and he has designed special 'immersion tubes' whereby fungi can be directly isolated from the soil. Prof. Chesters' mycological activities are by no means confined to the university, for he is a prominent and active

member of the British Mycological Society, serving as secretary during the period 1936–42 and becoming a vice-president in 1942.

Botany at University College, Leicester

MR. T. G. TUTIN has been appointed lecturer in charge of the Department of Botany, University College, Leicester. Mr. Tutin obtained his degree at Cambridge (Downing College) in 1930. He was demonstrator in botany at King's College, London, during 1938–39, and assistant lecturer in botany at Manchester during 1939–42. Recently, he has been working for the Admiralty. He visited British Guiana in 1933 and was a member of the Percy Sladen Trust Expedition to Lake Titicaca, Bolivia, in 1937.

Military Health Services in the U.S.S.R.

STRIKING figures in regard to the decreased death-rate among wounded Soviet soldiers were given by Dr. S. A. Sarkisov, professor of neuropathology at the Moscow Institute of the Brain, in the course of an address to the Pharmaceutical Society of Great Britain on February 8 on the health services of the Soviet Union. He said that modern warfare, involving huge armies, with its extreme mobility, its complicated tactics and strategy, and its swift wedges driven into almost completely devastated areas, has changed the whole structure of the organization of the medical service and lays entirely new demands on it, especially where first aid is concerned. Further complications are added by the use of new and powerful weapons such as mines, splinter bombs and so on. Whereas in the War of 1914–18 the majority of wounds were caused by bullets, in the present War they are due to mine and other splinters. These provoke grave wounds, extremely susceptible to infection. Despite all this, important progress in wound treatment has been made. During this War there have been only isolated cases of gas gangrene; the percentage of amputations is considerably lower than during 1914–18; the death-rate caused by bladder wounds has been reduced to a very great extent. Further improvements have resulted in a remarkable decrease of the death-rate among wounded men in the hospitals. This rate is now only 1·1 per cent, and the percentage of wounded men who have returned fit to the front is now 73 per cent. During 1914–18 it was 40 per cent. In addition, there have been no epidemics in the U.S.S.R. This is all the more significant when it is remembered that the considerable medical problems connected with the large-scale transfer of industries to the eastern parts of the country took place in the early stages of the War.

The Cinematograph Film in Medical Education

IN a leading article on the uses of the film for medical education, the *Lancet* (601, Nov. 4, 1944) reminds us that Dr. Braun filmed the mammalian heart in 1897 and, in that year also, Schuster, of Berlin, filmed the abnormal gait of some of his patients. The first surgical operation was filmed by the famous French surgeon, Doyan, in 1898. Yet in 1941, the *Lancet* directed attention to the fact that academic circles in Great Britain had then scarcely noticed "this new weapon". Those who were medical students in Manchester in the days of that great and progressive teacher of physiology, Prof. William Stirling, will remember the thrill they had when Stirling returned one day from Paris, to which he was a frequent visitor, with a film of trypanosomes in the blood. This must have been about 1906–10.

Since those days the film has become a different thing. How valuable it may be we may learn from the articles by C. J. Longland and Ronald McKeith and by B. Stanford in the *Lancet* (*loc. cit.*, pp. 585 and 588). Longland and McKeith deal with the present use of the film for medical education, and the supply of films and information, giving a valuable list of organizations from which medical films can be obtained. They also discuss the use of medical films abroad, the question of how they can help medical education, plans for their use and the job of their production. Stanford gives his article to this problem of production and to the scope of the medical film. In the same issue of the *Lancet* (p. 615) is a note on the apparatus used in one of the laboratories of Imperial Chemical Industries, Ltd., for cinemicrography, and on another, more elaborate apparatus for high-power cinemicrography designed by R. McV. Weston (see also *Nature*, November 4, 1944, p. 573).

The Research Defence Society

THE annual report of the Research Defence Society, published in the *Fight Against Disease* (32, 2; 1944), records further progress during 1943 and a gratifying response to the appeal for funds made in 1943. This has given the Society an additional £140 a year and an addition of £530 to its invested reserve, which now stands at its highest figure in the Society's history. But its total annual receipts of about £1,000 compare sadly with the statement also made, that opponents of animal experiments have spent, during the last thirty-two years, some £750,000 of charitable money in their efforts to stop experiments requiring the use of animals. The Society hopes, nevertheless, to resume its full activities after the War, under the presidency of Lord Hailey, who succeeds the late Sir William Bragg. The annual report directs attention to the success of diphtheria immunization and to the importance of vaccination in the control of smallpox demonstrated by the recent outbreaks in London and Glasgow. The Society's publications on these and similar subjects are being used to counter systematic efforts to prejudice mothers against protection of babies against smallpox and diphtheria by sending them misleading pamphlets at hospitals and nursing homes.

The present issue of the *Fight Against Disease* contains, in fact, short articles on the part played by animal experiments in the study of various grave diseases, which should be valuable in countering anti-vivisection propaganda. The late Sir John Ledingham contributed a list of important advances due to, or greatly helped by, experiments on animals, among which are the prevention of diphtheria, tetanus (the menace of which has been virtually excluded from the British and American Armies during the present War), typhoid, cholera, plague, rabies and smallpox; the diagnosis of syphilis, typhoid and paratyphoid, typhus, tuberculosis in cattle and such virus infections as influenza and yellow fever also require the use of animals; the sera for the detection of human and animal blood stains in criminal and other investigations are obtained from specially immunized animals; and animals also provide the sera used for the treatment of diphtheria, tetanus, gas gangrene, dysentery, typhus and other diseases.

Sir William Savage discusses the relation of animal experiments to the control of typhoid and other

infectious diseases, tuberculosis, venereal disease and to other problems of public health and nutrition. Prof. J. H. Burn discusses their relation to the standardization of such therapeutic substances as insulin, neoarsphenamine and various antitoxic sera. Dr. J. W. Trevan further discusses physiological, immunological and therapeutic researches done with animals for the control of human and animal diseases, instancing diabetes, rickets, beriberi, pellagra, diphtheria, gas gangrene and, in veterinary medicine, lamb dysentery (which used to kill hundreds of thousands of new-born lambs each year) and louping ill of sheep. He states that tuberculosis has been virtually eliminated from cattle in the United States by the use of tuberculin for its diagnosis. We also owe the sulphonamides entirely to work done with animals, and many other drugs cannot be standardized without the use of them Prof. George Wooldridge discusses the relief of pain and suffering in animals themselves due to experiments done on animals.

Tyndall's Library

MESSRS H SOTHERAN of 2 Sackville Street, Piccadilly, W 1, have just issued an annotated catalogue of works on physics comprising the library of John Tyndall (1820–93), professor of natural philosophy at the Royal Institution, and including also other items. Of special interest are such unique items as a manuscript catalogue of the library with nearly two thousand entries, together with numerous scientific notes of Prof. Tyndall and short autobiographical details of his boyhood. Another notebook of seventy pages contains notes of his original drafts of papers and reviews with suggestions of experiments to be made. A great deal consists of personal notes, not without their humorous aspect. Of Forbes he writes, "The late Principal J. D. Forbes was a man not slow to anger. He was so sensitive as to his fame, and so eager to secure it that honest criticism was regarded by him in the light of personal attack"—typical English understatement remembering the Forbes–Rendu–Tyndall glacier controversy. Other notes connected with Ruskin and Prof. Tait include "I have heard Prof. Tait described as a rude overgrown schoolboy". The same note-book contains the first draft of his sensational presidential address at the Belfast meeting of the British Association. The catalogue of more than a thousand items includes many volumes with Tyndall's pencilled notes. Such rare works as a first edition of Huygens "Traité de la Lumière" with the full name on the title-page also appear.

Industrial Safety in Spain

A PAPER by Luis Ruiz-Castillo Basala entitled "Eliminación de accidentes en la 'Industria de la Construcción' por el conocimiento del factor humano" appears in *Revista De Formacion Y Documentacion Profesional* (**3**, No. 9. Madrid, 1944), dealing with the problem of obviating accidents to those included in the category of the "Industria de la Construcción". The investigation was conducted for this class only, which includes twenty-four different forms of employment, constituting about 70 per cent of the manual workers in Spain (agricultural workers are excluded). Each of the occupations is examined separately, and the most relevant conditions which characterize them are given under the headings of physiology, psychology, hygiene and other factors. It is believed that accidents could be eliminated to a very large extent in the branches of industry referred to by attending to certain points, among which may be noticed the following. (1) Selection of those most adaptable to the particular type of work This could be effected by a physico-technical examination of special type, starting with a study of the characteristics enumerated for the various forms of employment. (2) Psychological influence by means of conversation, etc., on those who come under examination, to help each one to make use of his psychological qualities in the fulfilment of his daily occupation. (3) Propaganda by means of posters, handbills, and so on, having the special object of eliminating accidents. These would teach people the most convenient positions to adopt at their work and the most rational methods for proceeding with it, and would also show the necessity for remembering on all occasions the attitudes of security most fitted to avoid foreseen risks.

Announcements

THE Buchan Prize for 1945 of the Royal Meteorological Society has been awarded to Mr. E. L. Hawke, secretary of the Society.

THE Secretary of State for the Colonies has made the following appointments to the Colonial Products Research Council Mr. J. C. F. Fryer, secretary of the Agricultural Research Council, in succession to the late Dr. W. W. C. Topley ; Prof. H. V. A. Briscoe, head of the Department of Inorganic and Physical Chemistry, Imperial College of Science and Technology, in succession to the late Sir John Fox, Government chemist.

THE Council of the University of Sheffield has made the following appointments : Mr. J. H. Read, to be lecturer in chemistry ; Dr. E. F. Finch, to be honorary lecturer in the history of medicine, in succession to Mr. George Wilkinson , Mr. J. Carson, to be honorary lecturer in psychology in the Faculty of Medicine, in succession to the late Dr. E. F. Skinner.

OWING to the generosity of the Rockefeller Foundation of New York, which has for a fifth year in succession provided a grant for the purpose, the Royal Society is in a position to give assistance to scientific societies and associations which, as a result of war conditions, are experiencing financial difficulties in the publication of scientific journals.

A WHOLE-DAY conference of the Nutrition Society will be held on February 24, beginning at 11 a.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. The subject of the conference will be "Factors Affecting the Nutritive Value of Bread as Human Food". Further details of the Nutrition Society can be obtained from the Hon. Secretary, Dr. Leslie J. Harris, Nutritional Laboratory, Milton Road, Cambridge.

WE have received from Messrs. Griffin and Tatlock, Kemble Street, Kingsway, London, W.C.2, particulars of some apparatus and materials, including a neat balance desiccator, polishing alumina for metallography, an anti-vibration balance table, a Kjeldahl apparatus for determining nitrogen in steel, and several other types of analytical apparatus. Publications on these may be obtained on request.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electron Microscopic Investigation of Precipitates of Cellulose Nitrates

THE preparation of cellulose for electron microscopy is very difficult, because it implies the necessity of disintegrating the fibres to very thin fragments (10^2–10^3 A.). Different mills combined with swelling agents have been used, but the difficulties are not overcome by these methods. The results obtained do not always agree, and different conclusions have been drawn on the structure of the cellulose[1]. Of great value are the comparisons with light and electron microscopy made by Eisenhut and Kuhn[2], Barnes and Burton[3] and others. Good pictures have also been published by Husemann and Carnap[4]. In the investigations reported hitherto, preparations have been made by disintegrating fibres. Preparation by precipitating cellulose from cuprammonium solution has been used only in one case[5]. Precipitations of cellulose derivatives for electron microscopy do not seem to have been used at all. We have tried to get electron microscopic preparations of cellulose nitrates precipitated from acetone solution by water. The following is a preliminary report on these experiments.

The cellulose nitrates investigated were nitrated by a mixture containing phosphoric acid[6], and they contained about 13·8 per cent N. The precipitation was performed from a dilute acetone solution (0·02 gm./100 ml.). If the water was added slowly at about 50° C., with vigorous shaking, the cellulose nitrate formed an opalescent sol showing a distinct Tyndall effect. It was stable for many hours at a water concentration of 80 per cent. After standing for one or more days, the sol partially coagulated to filaments or lumps without definite shape.

In the electron microscopic investigation we used object membranes of nitrocellulose lacquer (cellulose nitrate containing about 12 per cent N dissolved in amyl acetate) of a thickness of about 50 A. We worked at a magnifying power of 20,000 (electron microscope with magnetic lenses from Siemens and Halske A.G.). The preparations were made by drying up a drop of the opalescent solution on the object membrane.

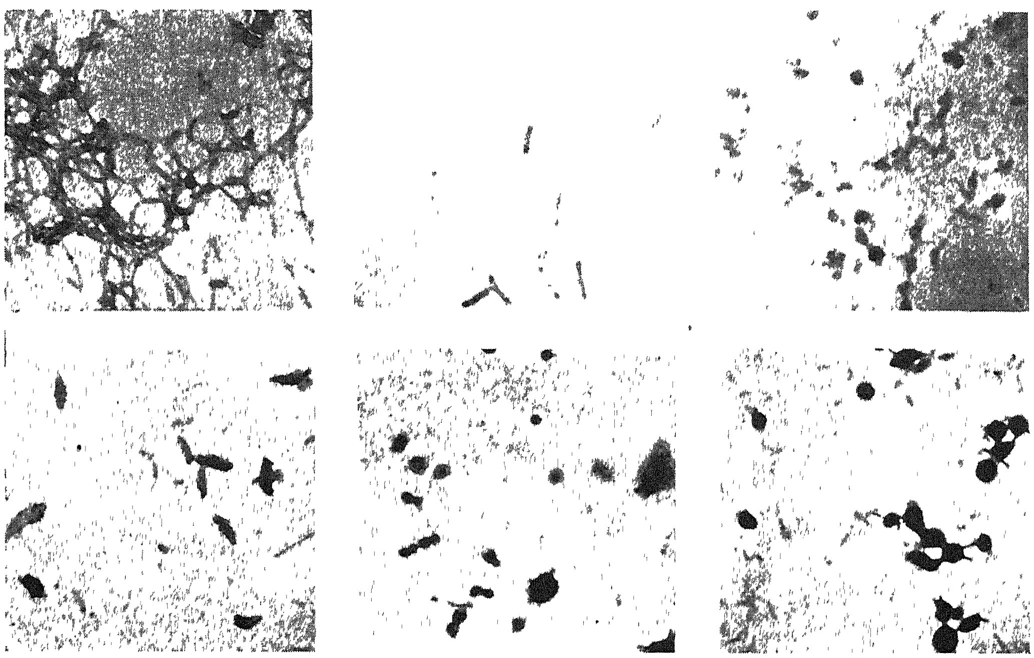
In these preparations there were different structures of the particles, and we have tried to classify them. As a preliminary description, the three main types of structures may be characterized as follows

1. *Micellar structure*, that is, straight rods or threads of rather uniform thickness and definite shape, sometimes lying free from one another but often crowded like a net over the membrane (length $\sim$ 2000 A and thickness $\sim$ 100 A.). See Figs. 1 and 2.

2. *Amorphous structure*, that is, lumps or clods without definite shape and magnitude. See Figs. 3 and 4.

3. *Fine-grain bottom- or understructure*, that is, extremely thin formations, sometimes lying as a net but not so strictly ordered as the micelles. The

1 2 3



4 5 6

1. Sulphite cellulose (spruce), bleached and treated with strong alkali, α-content 98 per cent (Mo och Domsjo AB)
2. Sulphate cellulose (pine), bleached 'Kraft' pulp (Uddeholms AB)
3. Sample removed from a sulphite cellulose cooking (spruce) 9 hr 45 min after start (the cooking was completed in 19 hr) Lignin content 16·6 per cent before nitration. The nitrate was completely soluble in acetone
4. Russian raw cotton linters, not extracted or treated in any way, α-content 96 per cent. The nitrate dissolved to 96 per cent in acetone
5. Sulphite cellulose (spruce), bleached to extremely low viscosity by hypochlorite.
6. The cellulose from Fig 1, depolymerized to half the original intrinsic viscosity by the 'ageing' of alkali cellulose in the viscose process.

bottom-structure was often to be seen, together with the amorphous structure. See Figs. 5 and 6.

Using the method described, we have found that celluloses of extremely high molecular weight ($DP >$ 5,000 from sedimentation and diffusion measurements) give mainly amorphous structure (type 2, see Figs 3 and 4) and no, or very few and irregular, micelles Celluloses of moderate molecular weight ($DP \sim 1,000$) have a definite tendency to form micelles (Figs. 1 and 2); sometimes all the precipitate was of type 1 We have not been able to obtain micellar structures of this type from cellu'oses depolymerized in different ways to very low molecular weight ($DP \leqslant 300$), they form precipitates of type 2 and 3, often mixed, but sometimes thin and irregular micelles were observed in the bottom-structure

The lengths of the micelles observed are about 50 per cent of those computed from DP (sedimentation and diffusion measurements) for straight molecules The lengths agree rather well with those of the molecules computed from the frictional ratio according to the formulæ given by Burgers[7] (cf. ref. 8). The frequency curves of the lengths are narrow and show only one peak; the mode of the lengths varied from 1000 A. to 3000 A. for different samples.

We believe that the micelles observed are crystallites, and it is possible that they are identical with the micelles proposed for the structure of cellulose and its derivatives in the solid state.

There are celluloses with only small differences measured by the general methods of analysis (viscosity, content of α-cellulose, pentosans, lignin, ash, extractive matter and so on) but of very different value for technical use. By using the precipitation method described, we have found distinct differences between such pulps, too. Possibly the method may be used for the characterization of technical celluloses. Further experiments are in progress and the results will be published elsewhere.

We wish to thank the director of the Institute, Prof. The Svedberg, for his interest in this work and for helpful criticism. We also thank the Mo och Domsjo AB and the Uddeholms AB for financial support.

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Action of Penicillin on the Rate of Fall in Numbers of Bacteria *in vivo*

DURING work on the use of penicillin pastilles in oral infections, of which a preliminary report has been published[1], numerous experiments have been undertaken in order to determine the total and differential fall in numbers of different species of bacteria in the mouth and the rate of this fall, under the influence of penicillin. This rate of fall is of particular interest, and as it appears that certain deductions on the mode of action of penicillin can be drawn from the experiments, it is considered that it is worth directing attention to them in a separate publication. The technique of determining the rate of fall was as follows:

0·1 c.c. of saliva was added to a measured quantity of normal saline 1/50 c.c. of this mixture was then inoculated on to a blood agar plate. This was incubated at 37° C. for twenty-four hours, when the number of colonies was counted. From this figure the approximate number of bacteria per c c. of saliva was calculated.

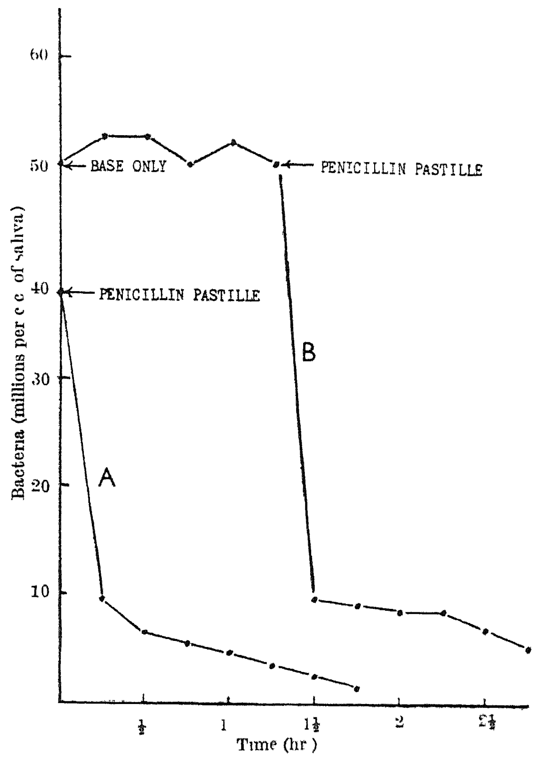
Immediately the first specimen of saliva had been obtained, a 500-unit penicillin pastille was placed in the buccal sulcus between the cheek and the teeth, and allowed to dissolve without sucking. A fresh pastille was inserted every thirty minutes. At fifteen-minute intervals further specimens were taken, and the number of bacteria later estimated in the manner described.

In these experiments saliva diluted with normal saline was used as the inoculum; it was therefore possible that the penicillin present in the saliva and transferred to the plate might be sufficient to inhibit growth: to guard against this action penicillinase was added to the medium.

The results of these experiments are shown in graph *A*, which represents the mean of three, though the findings have been constant in a far larger series of experiments using pastilles of different strengths.

It will be seen from this graph that the maximum fall in the total number of organisms occurred within the first fifteen minutes after the application of the penicillin.

Increased salivation due to the presence of a pastille in the mouth could have been a factor in this rapid fall, and in order to exclude this possibility the experiments were repeated using pastilles made of base alone, without penicillin. Pastilles of this type were maintained in the mouth for one and a half hours, and estimations on the total number of organ-



isms in the saliva carried out as in the previous experiments

At one and a half hours, pastilles of the same base, but containing 500 units of penicillin each, were inserted and maintained for an equal period of time. The results expressed in graph *B* show that the pastille base alone produced no reduction in the total number of organisms, but substitution of the pastilles containing penicillin caused a fall in numbers comparable with the results shown in graph *A*. The possibility of the mechanical effect of salivation causing a reduction in numbers of organisms could therefore be excluded.

Consideration of the results shows that the most rapid fall in the total number of bacteria occurred in the first fifteen minutes after application of the penicillin. This rapidity of action is difficult to explain on the current hypothesis that penicillin is bacteriostatic, and would suggest that *in vivo*, when conditions of temperature, etc., are favourable, it may have a true bactericidal action.

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Action of Notatin on the Rous No. 1 Sarcoma Virus

As notatin exerts its antibiotic activity by virtue of the hydrogen peroxide produced by its oxidation of glucose to gluconic acid[1], it seemed worth while to try the action of this material upon the Rous No. 1 sarcoma, the causative virus of which is readily destroyed by oxidation[2].

A specimen of notatin, active at 1 in 500,000,000 against *Staph. aureus* when last assayed, was generously provided by Dr. J. H. Birkinshaw. It was found that 0·2 mgm. of notatin, added with 2 mgm. glucose to 0·5 ml. of a suspension containing 1,000 minimal infective doses of Rous No. 1 sarcoma virus partially purified according to the method of Amies and Carr[3], resulted in almost complete loss of activity of the virus in 1½ hours, in two separate experiments. Notatin alone caused a slight reduction in the activity of similar suspensions, while glucose alone had no effect.

In contrast to the activity of notatin *in vitro*, it was found to have no action upon the virus *in vivo*. Amounts ranging from 2 mgm. to 5 mgm. were inoculated into one tumour of six fowls bearing three or four Rous No. 1 sarcomas in various sites, but it was found that all tumours continued to grow, and the size of the treated tumour relative to the others was not decreased. Doses of 8–10 mgm. were fatal to the nine-week-old Brown Leghorns employed. Similarly, pre-treatment of fowls with notatin failed to influence the tumour-producing action of sarcoma virus injected shortly afterwards. Two groups of three birds were injected with either 2 mgm. or 5 mgm. of notatin into the left breast, and 1½ hours later each breast was inoculated with about 200 infective doses of sarcoma virus, and the legs with about 10 infective doses. No difference in size was found between the sarcomas produced in the notatin-treated breast and those induced in the untreated side, and the small dose injected into the legs produced tumours in all birds, indicating that a systematic reduction in infectivity of all virus injected into notatin-treated birds had not occurred.

All expenses in connexion with this work were borne by the British Empire Cancer Campaign.

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Thromboplastic Activity of Placenta Extract

IN the course of an investigation of hormones of human placenta, we came across a substance which showed strong blood-coagulating properties. Fresh-water extracts of placenta contain this factor. Their activity diminishes when they are kept at room temperature or in a refrigerator. It is not removed from the extracts by dialysis at 0° C. On filtration through a Seitz filter, the active substance remains on the asbestos fibre. By extracting the filter with distilled water or saline, we obtained a solution possessing the properties of thromboplastin. The resulting slightly opalescent solution is more stable and can be stored for at least one month in a sealed container in a refrigerator without loss of potency. It gives a weak positive reaction with sulphasalicylic acid.

It is of interest that our preparation does not lose its thromboplastic activity when heated for five minutes on a boiling-water bath. This activity is manifested on recalcified oxalated plasma (prothrombin time test[1]) as well as on fresh whole human blood. The above holds true only for tests carried out with fresh plasma. With plasma stored for some days in the refrigerator a different result is obtained. As is well known, the prothrombin time test depends on the age of the plasma, being prolonged as the plasma is stored. Our placenta extract, too, shows this phenomenon. Towards stored plasma the boiled extracts become totally inactive (see table). Thus both our unheated and heated preparations show typical differences in behaviour towards fresh and aged plasma respectively.

EFFECT OF BOILED AND UNBOILED THROMBOPLASTIN ON THE 'PROTHROMBIN TIME' OF FRESH AND STORED PLASMA

Age of plasma	Prothrombin time	
	Unboiled thromboplastin	Boiled thromboplastin
1 hour	12 sec.	12 sec.
1 ,,	13 ,,	13 ,,
1 ,,	15 ,,	18 ,,
2 days	18 ,,	23 ,,
3 ,,	21 ,,	28 ,,
7 ,,	42 ,,	185 ,,
28 ,,	70 ,,	more than 10 min.

Prothrombin time is the clotting time of 0·1 c.c. oxalated plasma mixed with 0·1 c.c. thromboplastin and 0·1 c.c. 0·02 *M* calcium chloride at 37° C.

Extraction of ox lungs and brain has yielded a substance with similar properties, but preparation from placenta is technically easier. (Recently, Reichel[2] reported a thermostable blood-coagulating

substance from placenta, using a different method of preparation. Because of war conditions, I have not been able to secure a copy of this paper.)

Quick[3] has shown that prothrombin is composed of two components, A and B, the former of which disappears when blood is stored. This observation offers a possible explanation of our findings. It is assumed that our thromboplastic substance, too, is composed of two parts, one of them thermostable and acting on component A but not on component B of prothrombin. From stored plasma component A is lost. For this reason the boiled thromboplastin does not act on such plasma.

A full report will be published elsewhere.

My thanks are due to Prof. B. Zondek for suggesting this work and for the interest taken in its progress, and to Drs. Bromberg and Polishuk for their kind help.

The work was aided by a grant from the Rockefeller Foundation.

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Inhibition of Bone Calcification by Sulphonamides

THE recent demonstration by Golding and Silver[1] that certain sulphonamides act as inhibitors of phosphatase *in vitro* has led us to present a preliminary report of our investigations on the effect of sulphonamides on bone formation *in vivo*.

These experiments were designed to test a hypothesis which arose from the findings of Benesch *et al.*[2] that sulphonamides with a free $-SO_2NH_2$ group (for example, sulphanilamide) inhibit shell formation in the domestic fowl, whereas sulphonamides in which the $-SO_2NH_2$ is substituted (for example, sulphapyridine) do not. The former type of compound is a powerful inhibitor of carbonic anhydrase, while the substituted type does not have any effect on this enzyme, as was shown by Keilin and Mann[3]. It was therefore concluded that carbonic anhydrase is active in shell formation by catalysing the rate of formation of the carbonate anion of the calcium carbonate shell material.

Since bone also contains considerable quantities of carbonate, it was thought that carbonic anhydrase, in addition to phosphatase, may play a part in bone formation. In order to test this hypothesis, a calcification mechanism had to be selected which, like shell-formation, would be rapid enough to reveal the influence of sulphonamide levels compatible with life on the rate of calcification. It was therefore decided to use the calcification of the developing embryo for this purpose.

Pregnant mice and rats were used in these experiments. The mice were divided into two groups which received sulphanilamide and sulphapyridine respectively in doses of 300 mgm./kgm. a day. The drugs were given *per os* in three equal doses daily during the last 7–10 days of the gestation period. The rats were similarly treated with 720 mgm./kgm. a day. Both histological and radiological examinations of the fœtuses at term were made to study the effect of this treatment on the skeletal development.

The outstanding histological difference between the fœtuses from the sulphonamide-treated rats and normal fœtuses from comparable litters was the almost complete absence of calcification, as judged by the hæmatoxylin staining of the decalcified knee joints (Figs. 1–3). These results must, however, be interpreted in the light of Cameron's observation[4] that "hæmatoxylin does not stain calcium salts, though it often identifies areas in which changes favourable to the deposition of calcium salts are taking place". The differences in the mice were equivocal, probably owing to the slight development of the skeleton at this stage, as well as to the lower dosage administered.

X-ray examinations of the sulphonamide-treated rat fœtuses revealed striking defects in various parts of the skeleton. These were most pronounced in the skull, the parietal bones of which appeared quite translucent.

It is obvious that the observed impairment of calcification cannot be interpreted as an inhibition of carbonic anhydrase alone, since both sulphanilamide and sulphapyridine had the same qualitative effect. Despite the demonstration by Ercoli and Ravazzoni[5] that the activity of phosphatase from rice bran and from *Aspergillus oryzæ* is not noticeably influenced by sulphanilamide, Blum's observation[6] that certain sulphonamides inhibit bone phosphatase suggested that the effect may have been due to phosphatase inhibition. The confirmatory demonstration by Golding and Silver that both sulphanilamide and sulphapyridine inhibit bone phosphatase *in vitro* makes this interpretation more likely. It is, however,

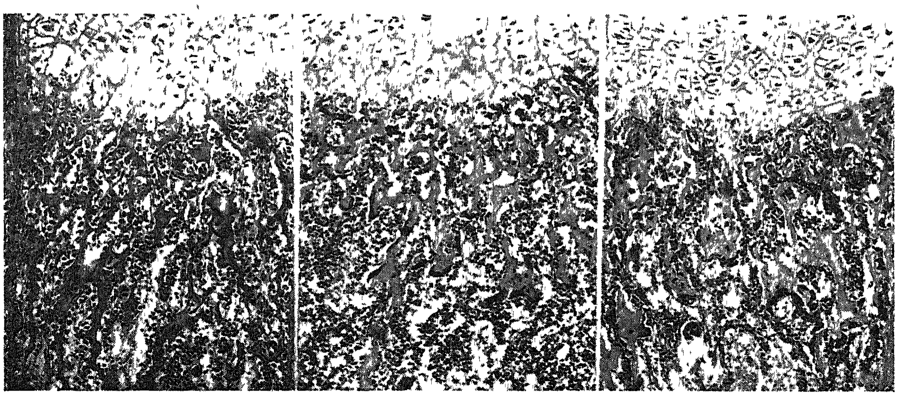

Fig. 1. Fig. 2. Fig 3.

LONGITUDINAL SECTIONS OF LOWER END OF FEMUR OF FŒTUS FROM (1) CONTROL RAT SHOWING BASOPHIL STAINING OF THE BONE TRABECULÆ, (2) SULPHANILAMIDE-TREATED MOTHER, SHOWING ABSENCE OF BASOPHIL STAINING OF THE BONE TRABECULÆ; (3) SULPHAPYRIDINE-TREATED MOTHER, SHOWING ABSENCE OF BASOPHIL STAINING OF BONE TRABECULÆ. HÆMATOXYLIN AND EOSIN. × 75.

still possible that in the case of sulphonamides with a free $-SO_2NH_2$ group, carbonic anhydrase inhibition may have been masked by the concurrent phosphatase inhibition.

In conclusion, it is pertinent to point out that whereas the dosage used in our experiments was about seven times the therapeutic one, the resulting blood-levels would, however, be still very much lower than the concentration used by Golding and Silver to demonstrate gross phosphatase inhibition *in vitro*.

Further work is in progress on the lines discussed in this communication.

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Insecticidal Sprays and Flying Insects

It has already been reported that insects are comparatively little affected if they remain motionless in an insecticidal spray of droplet size less than 10 microns in diameter[1]. However, when they fly through such a mist, the insects collect a very large number of droplets on their wings. This observation has been shown to be true in the case of *Aëdes ægypti*, *Musca domestica* and *Drosophila* spp. which have been exposed to both oil and water sprays.

The oil droplets which are collected by the wings do not spread since they are held by the microtrichia (Fig. 1), but on the rest of the body small droplets, applied directly, spread quickly. When the spray consists of a dyed dilute aqueous gum solution the situation is rather different, since the droplets do not spread either on the wings or on the body surface (Fig. 2). Now a few droplets can be seen on the antennæ, mouth parts, eyes, halteres and spiracular guard hairs, and the house-fly also collects very many on the ventral side of the abdomen. It remains true to say, however, that by far the largest number of droplets is collected on the wings.

It is not difficult to demonstrate the insecticidal importance of the spray collected on the wings. When the wings of both *Aedes* and *Musca* are removed just after exposure to an oil spray mist, the kill recorded twenty-four hours later is reduced by about 50 per cent in comparison with an unoperated control group.

As is well known, insects use their legs to clean their heads, antennæ and wings; and it is, therefore, not surprising to find that droplets which have impacted on these parts are later removed and collect in the first place on the legs (Fig. 3). From the legs the spray may be transferred to the substratum or, as in the case of the fore legs of the house-fly, it may be cleaned off by the proboscis.

Insects which are being exposed to a spray mist commence the cleaning process as soon as an appreciable number of droplets has been collected. As a result, streaks of dyed spray are deposited from the legs and can be seen on the walls of the cage in which the insects are being exposed. In this way much of the spray collected by an insect during flight will be removed and lost to the surroundings. During the process of removal, however, it will be passed over the legs, which in certain cases are known to be favourable sites for the entry of insecticide. The material removed by the proboscis passes through the gut and is apparent there and in the excreta. There is, therefore, the possibility that material collected on the head and its appendages may ultimately act as a stomach poison.

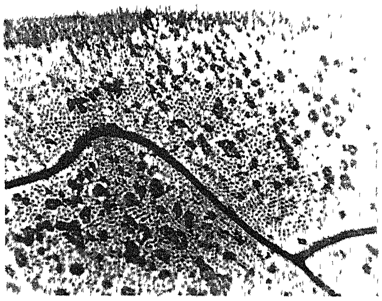

Fig. 1. Oil droplets held between the microtrichia on the wings of *Musca domestica*. They were accumulated during flight through an insecticidal mist

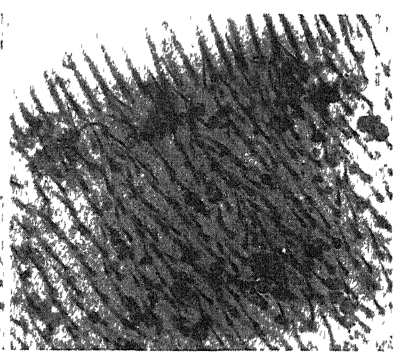

Fig. 2 Droplets of an aqueous spray on the wing of *Musca* collected during flight. Note the spherical form in contrast with the oil droplets of Fig. 1

Fig. 3 Droplets shown in Fig. 2 now entangled in the bristles on the first tarsal joint of the hind leg of *Musca*. These droplets have been combed from the wing

These observations are being extended, and it is hoped to publish a more detailed account at a later date.

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A Third Factor for Resistance to *Puccinia graminis Tritici*

We have recently found a third factor for resistance to *Puccinia graminis Tritici* race 34 present in the Kenya varieties of *Triticum vulgare*, and it is considered that a short statement concerning this would be of interest.

In Australia, varieties of *Triticum vulgare* from Kenya Colony, East Africa, have been used widely as a source of resistance to *P. graminis Tritici*. Three strains, Kenya 743, 744 and 745, have been utilized for this purpose. Kenya 743 (*C* 6040) is a parent of the commercial variety Eureka developed by the New South Wales Department of Agriculture Several new rust-resistant lines developed at this University owe their resistance to Kenya 745 (*C* 6042). Kenya 744 (*C* 6041) was used by wheat breeders in Western Australia since it is also resistant to race 95 of *P. triticina*, which occurs commonly in that State. Although we have used this latter variety, no promising lines have resulted from it.

Varieties of wheat from Kenya Colony have been investigated on the North American continent, and in Canada they have been found to be practically immune to many physiological races of stem rust under some conditions[1]. Since their resistance is much reduced by increasing temperatures they have not proved popular in the spring wheat areas. The effect of high temperatures, 75–80° F., on the rust reaction of seedlings has also been observed here in the glasshouse but it has never been important on adult plants in the field.

In New South Wales the standard race 34 of *P. graminis Tritici* formed the bulk of the stem rust inoculum until 1941, and all the above varieties were highly resistant to it. Genetical studies have shown that the resistance of each variety is apparently governed by a single major factor. Studies on F_3 lines have shown that in 744 the factor is the same as that previously recorded for resistance to races 17, 36 and 56 and the one in 745 is K_1, these factors being inherited independently[2]. These two factors are not allelic with the one present in Kenya 743, because when this variety was crossed with 744 and 745 in turn and F_2 seedlings were tested with the standard race 34, it was found that approximately fifteen were resistant and one was susceptible. Although a new rust capable of attacking Kenya 743 has recently turned up in Australia, 744 and 745 remain quite resistant to it. In these latter two varieties it seems that the same gene gives resistance to both the new and the old rusts.

Other varieties which were known to possess a single major gene for resistance to the standard race 34 have been crossed in turn with each of the above three varieties, and on the basis of the segregations of F_2 and F_3 seedlings their relationship to them was determined. So far, Kenya 744 is alone in one group but the other two groups are well represented. All varieties which fall into the group with 743 are susceptible to the new rust which attacks this variety, and at the University of Sydney they are all later in maturity than Kenya 745. Included in the 745 group are varieties of *Triticum vulgare* which have a single factor for resistance and which have derived it from Gaza (*T. durum*).

While there is clear evidence for the existence of these three independent genes no attempt has been made to allocate symbols to them, since this is at present being undertaken by the committee considering nomenclature of wheat genes.

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Dec. 20.

[1] Peterson, R. F, Johnson, T, and Newton, M *Science*, **91**, 313 (1940)
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Nutrients in Wheat Endosperm

Recent work[1–4] has added considerably to our knowledge of the distribution of nutrients, particularly the B vitamins, in the wheat grain. The scutellum portion of the germ is the main deposit of vitamin B_1, while the bran is rich in nicotinic acid and iron. Riboflavin is more uniformly distributed throughout the grain, although the highest concentrations are found in the germ. Further work has now shown that the endosperm, far from being uniform in composition, has a complex and graded structure

The endosperm of wheat is bounded by the aleurone layer which is reputedly rich in protein and minerals. In normal milling, however, this aleurone layer, together with an appreciable amount of 'starchy' endosperm, remains firmly attached to the bran. It has long been known that the concentrations of protein and ash increase from the centre to the outer part of the endosperm adjoining the bran or seed coat; Cobb[5], for example, found with one sample of wheat that the protein in the central endosperm averaged 7·4 per cent against 16·5 per cent near the periphery. Binnington and Andrews[6] have also obtained evidence showing that the endosperm adjacent to the bran is much richer in vitamin E than the endosperm contained in patent flour. It has now been found that there are similar gradients for other nutrients. In one experiment a mixture of English wheats was milled on the laboratory plant to produce a short patent flour. The coarse bran was then freed so far as possible from adhering endosperm by four successive passages through a pair of fluted rolls. These four fractions (sieved finally through a 14 silk:

Factor	Endosperm fractions (corrected for bran contamination)				Cleaned bran	Whole wheat	Patent flour
	1st	2nd	3rd	4th			
Fibre (per cent)	—	—	—	—	11·5	2·0	—
Ash (per cent)	2·1	3·9	5·9	7·7	6·54	1·49	0·39
Protein (per cent)	13·6	14·3	15·6	16·2	11·4	8·9	8·1
Iron (mgm./100 gm.)	6·4	11·3	16·0	21·4	12·4	2·95	0·54
Total P (mgm./100 gm.)	490	937	1440	1850	1494	311	59
Phytate P (mgm./100 gm.)	371	805	1245	1593	1280	213	< 10
Phytate P/total P	0·78	0·86	0·86	0·88	0·86	0·68	< 0·17
B_1 (I.U./gm.)	1·4	1·8	2·1	2·3	1·6	1·03	0·13
Riboflavin (μgm./gm.)	1·9	1·5	1·7	2·0	5·0	1·55	0·4
Nicotinic acid (μgm./gm.)	77	148	240	393	250	42	5
Theoretical per cent by weight of wheat	0·89	0·39	0·34	0·43	12·5	100	11

aperture 0·095 mm.) together with the residual coarse-cleaned bran were carefully analysed. From the fibre contents of the fractions it was possible to calculate the amount of powdered bran in each fraction and in turn to arrive at the approximate composition of the pure endosperm in each fraction. Certain of the results, together with those for the cleaned bran, the whole wheat and the patent flour (roughly typical of the central endosperm), are given in the accompanying table.

From the method of preparation it would be expected that the fractions contained increasing amounts of aleurone cell contents, but in general the analyses are typical of the starchy endosperm adjoining the aleurone layer. Other experiments, however, indicate that the slopes of the gradients in the endosperm, certainly that for protein, vary in different samples of wheat.

Four points stand out from these results: (1) the outer endosperm is particularly rich in protein, iron, nicotinic acid and phosphorus; (2) the B_1 content, although much higher than in patent flour, is low compared with that in the scutellum where it averages 60 I.U./gm.; (3) the bulk of the phosphorus is in the form of phytate P (this incidentally is also true of germ[1] and aleurone layer[7]); (4) the total weight of endosperm included in the four fractions was approximately 2 per cent of the weight of the wheat, corresponding to a thickness of about 12 μ. Analyses showed that the coarse bran after cleaning still had its aleurone layer practically intact and contained in addition about 5 per cent starchy endosperm (thickness approximately $3 \cdot 5\ \mu$).

This work is part of a general investigation on the detailed chemistry of the wheat grain and the biophysics of flour milling.

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Jan. 2.

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Sources of London Honey

It is well known that the main nectar flow in the London area comes from the limes (*Tilia* spp.) and to a lesser extent from the privet (*Ligustrum*). In some seasons privet predominates and the resulting honey is dark in colour with a slight greenish cast and has an unpleasant flavour with a bitter after-taste. The honeys that were the subject of my note[1] could not be mistaken for privet honey. The colour of the *Ailanthus* honey is a pale amber with a more definite green tinge than any other honey I have seen. Mr. Farmiloe[2] has evidently misunderstood my description of the flavour. It is quite distinct from that of privet honey, which does not develop the muscatel flavour. The cat-like odour referred to is that of tom-cat urine and differs from both *Ribes nigra* leaves and the musky smell of mice. The odour of *Ailanthus* flowers is strong and similar to that of fresh elder flowers (*Sambucus nigra*), which changes when they wilt to the tom-cat odour. The odour of *Ailanthus* leaves is different from that of either fresh or wilted elder flowers, but it is irrelevant to this discussion. Another point confirming *Ailanthus* as the source of the cat-like and muscatel flavours is that there was no marked difference of flavour between the two honeys, although in 1944 there was nearly five times as much privet pollen present as in 1943.

That the proportions of pollen species found in a honey do not represent exactly the relative amounts of nectar obtained from the source plants is appreciated full well by palynologists—to use the term recently proposed by Hyde[3]. Many factors contribute to this lack of correlation in addition to the peculiarities of the bee's honey sack quoted by Mr. Farmiloe. To take an extreme case, no pollen can be gathered from the garden catmint, *Nepeta Mussinii*, so beloved of the bees, as the plant has sterile anthers. Generally, however, the pollen content of a honey is a good indication of the botanical sources of the nectars from which it was derived. Thus in a honey pronounced by a well-known honey judge to be one of the best samples of raspberry honey he had seen, 79 per cent of the pollen came from raspberry. Pollen from another honey reputed to be from fruit trees consisted of 68 per cent of fruit tree pollens, more than 50 per cent being apple. Other constituents in this were horse-chestnut 10 and *Tilia* 1 per cent. These particular analyses probably indicate fairly closely the composition of the honeys. On the other hand, diœcious trees like *Ailanthus* will tend to be under-represented as the female flowers have no pollen. Sweet-chestnut, *Castanea sativa*, on account of its abundant and fully exposed pollen, will tend to be over represented in a mixed honey containing lime, privet and other plants flowering at the same time. Floral morphology and relative abundance of pollen must both be important factors affecting the amount of pollen finding its way into the honey.

It has been my experience that the preconceived ideas of beekeepers as to the floral sources of their honeys are frequently at fault. All the evidence I have gathered suggests that the pollen content is a very useful, though not yet quantitative, indication of origin, and reflects more or less faithfully the history of the bees' labours. For example, the presence of the lime and horse-chestnut pollens in the fruit tree honey mentioned above was explained on inquiring into the history of the hive. The beekeeper had been too busy to extract the honey and had left the supers on the hive until she noticed the first open flowers on the limes. Evidently the bees had already found the lime and had previously worked the horse-chestnut. This honey also shows the working of two separate nectar flows, a feature in evidence in the analysis quoted by Mr. Farmiloe. The most unusual feature of his honey is the high proportion, 27 per cent, of monocotyledonous pollen, for there can be few places in London where such a result is possible.

Exception must be taken to some of the statements quoted from Mr. Yate Allen. The limes produce pollen in fair abundance and moderate amounts are carried back to the hive. The amount of pollen produced bears little or no relationship to the orientation of the flowers. Although anemophilous and nectarless flowers are worked, when the demands of the brood require it, not much pollen of this kind finds its way into the honey. In normal circumstances the bulk goes directly into the brood nest.

While it may be agreed that chemical methods of identification and quantitative estimation of the

botanical sources of honeys are desirable, the chemist has yet a long way to go before he can analyse a 5 gm. sample of honey and state with an error of ± 5 per cent the percentage composition in, say, a mixture of horse-chestnut, sweet-chestnut, lime and privet The mere identification of a readily recognizable substance such as methylanthranilate is but a beginning Such a goal is probably more nearly within reach of the palynologist.

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Royal Botanic Gardens,
Kew, Surrey. Jan. 31.

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[2] Farmiloe, C , *Nature*, **155**, 80 (1945)
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Duration of the Larval Stage of *Echinometra*

By adding every day a small quantity of food to cultures of *Echinometra* larvæ, Onoda[1] was able to grow them to full larval shape in forty days from fertilization. Mortensen[2] succeeded in growing larvæ of the same species to metamorphosis in eighteen days. He transferred the larvæ every day, by means of a pipette, to fresh sea-water, thus giving them access of their natural food. Using Mortensen's method, but transferring the larvæ to fresh sea-water twice a day, I have been able to grow them to metamorphosis in twelve days only. Attempts are being made to rear these and other larvæ in order to find the minimum duration of the larval stage; the results will be published elsewhere.

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Preparation of Stable Colloidal Solutions of Carcinogenic and other Water-Insoluble Compounds

E. BOYLAND[1] prepared colloidal solutions of 1 : 2 : 5 : 6 dibenzanthracene by using acetone as a solvent with the addition of a gelatine solution. Following Berenblum's technique[2] by using pyridine as a solvent with the addition of a solution of gum arabic, P. H. O'Hara and J. A. Pollia[3] succeeded in preparing colloidal solutions of low concentration of carcinogenic hydrocarbons. N. Waterman[4] prepared colloidal solution using acetone-water dispersions of carcinogenic hydrocarbons. The acetone was evaporated in vacuum. M. Wolman[5] obtained a colloidal solution by the dispersion of acetone solutions of carcinogenic hydrocarbons in water; the acetone was evaporated in large Petri dishes exposed at room temperature.

As neither of these methods, nor the evaporation of the organic solvent on a water-bath, was practical or convenient for our purpose[6], the following procedure was adopted.

The water-insoluble compounds are dissolved in a small volume of acetone, in a test-tube, and added drop by drop with continued stirring in a given volume of distilled water, depending on the required concentration. The test-tube is washed out with another small volume of acetone and this also added to the water. The colloidal solution is then freed from acetone by dialysing against distilled water for 2–3 hours as follows The colloidal acetone-water mixture is poured into a 'Cellophane' bag, the mouth of which is securely fastened about a glass tube The bag with its protruding glass tube is suspended in a beaker into which distilled water was introduced, allowing the diffusion of the acetone from the mixture into the water. Within 2–3 hours the mixture is freed from acetone. If the water is changed two or three times the period of diffusion may be reduced. The acetone-free colloidal solution is then brought to the desired volume according to the concentration required.

In this simple way we have succeeded in preparing stable and perfect colloidal solutions of any desired concentration (in our experiments we could prepare solution of more than 1 per cent concentration) of almost all carcinogenic and other related and unrelated compounds such as 1 : 2 : 5 : 6 dibenzanthracene, 3 : 4 benzpyrene, methylcholanthrene, anthracene, pyrene, phenanthrene, cholic acid, desoxycholic acid, cholesterol, œstrone, ergosterol, etc.

We have still to test this method for other water-soluble solvents.

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[4] Waterman, N., *Internat. Kong Krebsforsch.*, **2**, Reference 2 33 (1937) Bruxelles
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Commutation of Annual Subscriptions

MR. J. H. UNNA, in *Nature* of December 9, makes the point that it almost always pays members of scientific and professional institutions who are 'good lives' to commute their annual subscriptions. The great practical objection to this is that a member who commutes is no longer able to make his disapproval felt by resigning. On the contrary, his resignation puts money into the institution's pocket.

It is not difficult to imagine circumstances in which the control of an institution might pass into the hands of a minority, or in which the country and foreign members might object to a policy decided by those who happen to live near London. Foreign members in particular are often disenfranchized entirely, even when questionnaires or voting papers are circulated to all members, since the closing date is usually such that foreign replies arrive too late.

In any such circumstances a dissatisfied member, so long as he pays an annual subscription, can in the last resort exert pressure of a practical kind by withdrawing. This real power should not lightly be forfeited. The professional 'man in the street' may finally have to apply economic sanctions to the scientific and professional institutions in order to force those measures of rationalization which, as the editorial in *Nature* of December 9 points out, have been so long delayed.

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RESEARCH ITEMS

Mould Inhibition of the Tubercle Bacillus

It is well known that Sir Alexander Fleming discovered penicillin because a mould accidentally contaminated one of his plate cultures. Reference is made in the *Lancet* (632, Nov. 11, 1944) to the work of D. K. Miller and A. C. Rekate (*Science*, **100**, 172; 1944), who found that the growth of a strain of the tubercle bacillus, *Mycobacterium tuberculosis*, was inhibited by a green mould of the *Penicillium* group, which accidentally grew on a culture of the tubercle bacillus stored in an icebox. The mould grew rapidly and well in other cultures of tubercle bacilli at room temperature, but it did not grow at all at 37° C. It grew faster and sporulated earlier on cultures of tubercle bacilli than on sterile media. It also grew in suspensions of human tubercle bacilli in saline at room temperature, and the authors failed to recover the tubercle bacilli from these suspensions later on. Experiments done by inoculation of guinea pigs suggested that some inhibition of growth had occurred, but were less definite. The mould grew well on tuberculin diluted as much as 1 in 10,000, and these dilutions of tuberculin thereafter failed to give positive skin tests in tuberculous guinea pigs. Suspensions of the mould inactivated 1 in 100 tuberculin in 2 hours, and the supernatant fluid obtained by centrifuging such suspensions also did this. When, however, the suspensions were passed through a Seitz filter, they did not inactivate the tuberculin. On the other hand, fluid media on which the mould had grown for 8–15 days had no effect on tuberculin or tubercle bacilli. *Staphylococcus aureus* grew on media on which the mould had grown and from which it had been removed, so that it was concluded that the substance produced by the mould which inhibits tubercle bacilli is not similar to penicillin.

South American Water Mites

An extensive memoir on the water mites (*Hydrachina*) of South Brazil and Paraguay by O. Lundblad is brought to a conclusion by the appearance of the fifth part (*Kungl. Svenska Vetensk. Akad.*, **20**; 1944). This consists of 182 pages with 58 text-figures and 10 plates and is of approximately the same size as the other parts which, however, contain more text-figures. The richness of this fauna can be judged from the fact that the present memoir treats of 340 species, sub-species and varieties, and its contribution to our knowledge from the fact that, included in this total, are 282 new species. In spite of this, however, the author considers that the list is by no means complete, for the country has not been so exhaustively covered as some parts of Europe. The summary and conclusions occupy nearly half the present part, with twelve comparative and distributional tables. These include one on all the members of the group that have so far been recorded from South America The seasonal distribution of the various forms is given, as is also their distribution among three different habitats, standing water, streams and brooks and springs. For the purposes of comparison with other southern hemisphere forms the author takes into consideration the previous work of K. Viets on the *Hydracharina* from the Sunda expedition. There is no doubt that this will form the classical work on South American *Hydracarina* for many years to come.

Lizard Heart

A very full account of the lizard heart, as illustrated by that of *Varanus monitor*, the Indian monitor, is given by P. N. Mathur (*Proc. Indian Acad. Sci.*, **20**; 1944). A number of new points have been noticed. A suspensory ligament and a sinu-atrial channel are described: both atria project for some distance into their respective ventricles and the author terms these the intraventricular portions: the apical region of the ventricle is divided internally into two cavities by a horizontal septum, and these are termed the cavum apicis dorsale et ventrale: the author suggests that the septum is not in its entirety the equivalent of the septum ventriculorum of higher forms as assumed by previous writers: it is further suggested that the names cavum arteriosum and cavum venosum, since they have a functional significance, should be replaced by cavum dextrum and cavum sinistrum. The bibliography, which is very full, is marred by certain slips that have not been corrected in the proof reading.

Strains of the European Corn Borer in the United States

Under the above title, K. D. Arbuthnot, of the U.S. Bureau of Entomology and Plant Quarantine, describes experiments conducted during 1937–40 on the possible occurrence of strains of this insect and their physiological relationships (*Tech. Bull. U.S. Dept. of Agric.*, No. 869; March 1944). It appears that material collected from New Haven, Conn., was found to be of a homozygous multiple-generation strain, and no evidence was obtained to indicate the occurrence of a single-generation strain in that locality. Material from Toledo, Ohio, was heterozygous, a complex of single- and multiple-generation strains occurring together. A homozygous single-generation strain was isolated from Toledo material but it was not found possible to obtain a homozygous multiple-generation strain. Larvae of the single-generation Toledo strain grew more slowly than those of the multiple-generation strain from New Haven. Moths from the Toledo and New Haven field-stocks each showed a preference for mating among individuals from their own locality rather than crossing between the stocks. Mating of New Haven females with Toledo males was obtained in only a few cases, because of a racial inhibition to such mating. From these and other grounds, which are stated in detail, the author concludes that distinct biological strains of the insect in question have been demonstrated by his experiments.

External Factors and Growth of Wheat

An attempt to assess the precise effects of differences in date and depth of sowing, conditions of spacing and kind of soil has been made by S. S. Labh Singh and Nek Alam (*Proc. Ind. Acad. Sci*, B, **19**, 29; 1944) in a study of one or two varieties of wheat grown in a series of randomized replicated blocks at two different localities. Irrespective of date, time or depth of planting, rate of germination was most rapid from midnight to 8 a.m. and slowest from noon to midnight. The optimum range for depth of sowing was large (½–3½ in.), deeper sowing being best for earlier planting and light soils needing deeper sowing than heavy ones. Shallow sowing at early dates gave a high seedling mortality. Spacing had no effect on the mortality and was the only factor which did not affect the rate of production of the first four foliage leaves. The main stems grew fastest but reached the shortest final height in late (January)

sown material, and such plants had a lower number (7·8) of fertile spikelets than the October sown plants (20·8). Wider spacing always gave more fertile spikelets. Head development in December material appears to have been at a critical threshold since the ears were long and lax in the more widely spaced material while under closer spacing they were very dense. It is concluded that in order to avoid discarding types which would be valuable introductions when grown under their optimum conditions, new varieties should always be given a very thorough trial under a wide range of conditions.

Root Stock and Scion Relationship

THE problem of root stock and scion relationship in grafted trees is one of interest and economic importance. Optimum growth and development of the grafted tree result only when scion and stock are compatible. Incompatibility generally results either in a failure of the graft to take, or else in reduced growth followed by an early death. E. L. Proebsting and C. J. Hauser (*Proc. Amer. Soc. Hort. Sci.*, **42**, 270; 1943) describe what may be a case of partial incompatibility between apricot scions and Myrobolan plum root stock. Apricots grafted on to this stock show a leaf scorch consisting of a cupping of the leaves, which are reduced in size and develop a marginal scorch. Excision of the dead tissue follows. The condition is neither cured nor prevented by injection of copper sulphate, boric acid, manganese sulphate, ammonium molybdate, zinc sulphate, thorium nitrate, potassium dichromate, barium chloride, sodium tungstate, cadmium sulphate or cobaltous acetate either alone or in various mixtures and is unlikely therefore to be a deficiency disease. On the other hand, scion rooting reduces the severity of the symptoms and diseased trees marched with apricot seedlings show a recovery.

Kalsilite-bearing Lavas of South-west Uganda

AT a meeting of the Royal Society of Edinburgh on December 4, A. D. Combe and Arthur Holmes presented a paper on "The Kalsilite-bearing Lavas of Kabiringe and Lyakauli, South-west Uganda". It has been known for half a century that Ruwenzori is flanked by a series of recently extinct volcanic areas, each of which consists of tuffs, explosion craters and rare lava flows. The first systematic survey of these volcanic fields was carried out by Mr. Combe during 1933–39, and representative collections, amounting to nearly 1,000 specimens, were sent to Prof. Holmes for petrological study. The rocks of this unique petrographic province are highly potassic ultrabasic types of which the chief members are the following:

Ugandite	=augite+leucite	with abundant olivine, perovskite and iron ore ± biotite ± glass
Mafurite	=augite+kalsilite ($KAlSiO_4$)	
Katungite	=melilite+leucitic glass	
Kalsilite-katungite	=melilite+kalsilite	

The lavas described in the present contribution lie near the eastern edge of the Western Rift Valley, south-east of Kazinga Channel. They are kalsilite-bearing throughout and consist of mafurite and various transitional varieties containing leucite and/or melilite. The tuffs that preceded and followed the lavas are typical of those of the province as a whole and contain (*a*) fragments of quartzite, phyllite and granite derived from the underlying bedrocks; (*b*) fragments of cognate sub-volcanic biotite-pyroxenite and -peridotite; and (*c*) lapilli of katungite. The lavas contain xenoliths of (*a*) and (*b*) in all stages of transfusion by magmatic emanations, the most significant change being the transformation of the minerals of granite into leucite and eventually into an assemblage of minerals equivalent to leucitite. This discovery throws much new light on the genetic relationships between the various volcanic rocks, all of which can be traced back to the magmas responsible for kalsilite-katungite and mafurite. Twelve new chemical analyses have been contributed by Dr. H. F. Harwood and others.

Dielectric Constant and Energy Loss in Solids and Liquids

IN a published paper (*J. Inst. Elec. Eng.*, **91**, Part 1, No. 48; Dec. 1944), H. Frohlich discusses the theory of the dielectric properties of a large group of solid and liquid organic substances built up of long-chain molecules, from the point of view of modern atomic and molecular structure. It is shown that in such substances dipoles have two equilibrium positions with opposite dipole direction. The static dielectric constant should increase with temperature below a critical temperature and decrease above it. The dielectric power loss for crystalline solids should be approximately described by the Debye equations, but for amorphous substances a flattening-out of the Debye loss curve is expected. For long-chain molecules the dependence of the time of relaxation on chain-length has been calculated, and the relevant equations are given in the paper.

Spectrophotometry of a Wolf-Rayet Binary Star

C. S. BEALS, Dominion Astrophysical Observatory, Victoria, B.C., has discussed the Wolf-Rayet Binary HD 193576, noticed first as a variable by Martin and Plummer in 1917 (*Mon. Not. Roy. Astro. Soc.*, **104**, 4; 1944). Its range of variation at that time was believed to be small, and in 1939 O. C. Wilson announced that it was a spectroscopic binary. Beals undertook a series of spectrographic observations in the summer of 1942. The data consisted of 61 spectra, 39 of which cover the region λ 3900–5000, while 22 are in the region λ 5300–6700. Comparison of line and band intensities with those of typical stars of the same spectral classes led to apparent visual magnitudes of 8·30 for the *O*-type star and 10·5 for the *W* companion. The distance of the binary is estimated from the strengths of the interstellar lines, and the value adopted is 1,180 parsecs. On the assumption of an effective temperature of 80,000° for the *W*-star and 40,000° for the *O*-star, the radii are 1·3 and 4·2 respectively, the radius of the sun being the unit. A discrepancy between the diameter of the *O*-star as determined from the light curve and as determined from the absolute magnitude and temperature is explicable on the assumption that the *W*-star may have a very small radiating core and also an extensive envelope capable of absorbing light from the *O*-star. Beals's results differ considerably from those of Wilson, who suggested that the origin of the Wolf-Rayet emission bands takes place close to the photosphere, a view which was based on the absence of a transit-time effect. This assumed complete spherical symmetry in the expanding envelope. Beals's interpretation of the spectrum of the binary suggests that tidal effects prevent this condition from being realized, even approximately in the envelope of the system. He pictures a shell of ionized helium surrounding the *W*-star only, the pair being surrounded by a larger shell of neutral helium; the ionized helium shell is distorted by the tidal action of the *O*-star, the mass of which is $2\frac{1}{2}$ times that of the *W*-star.

BIPHASIC ACTION OF PENICILLIN AND OTHER SULPHONAMIDE SIMILARITY

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and Dr. H. KITCHEN
Royal Naval Medical School

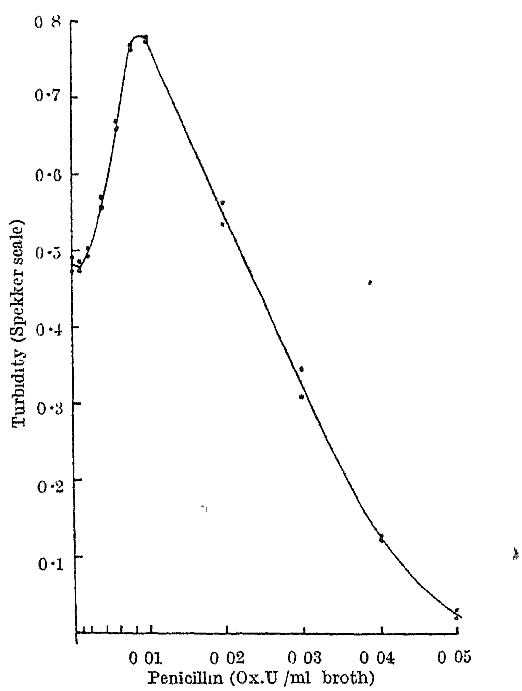
SUBSTANCES generally acknowledged as being toxic to cells may have an opposite effect in higher dilution. This biphasic action—inhibition in high concentrations and stimulation in low concentrations—has been observed with a wide variety of substances, including narcotics, cyanide, pyrithiamine[1] and sulphonamides[2]. There is ample evidence that low concentrations of the last group stimulate bacterial growth; and it would appear that the period of active proliferation, which frequently precedes bacteriostasis by sulphonamides in higher concentrations, is a manifestation of the same phenomenon. We here report what appears to be an expression of the same effect occurring with penicillin

The growth of sensitive bacteria in broth is quantitatively inhibited by suitably graded dilutions of penicillin, and the degree of inhibition can be measured turbidimetrically[3]. With the Oxford H staphylococcus (No. 6571 N.C.T.C.) as test organism, and measuring turbidity on the logarithmic scale of a Spekker photoelectric absorptiometer, we have obtained turbidity-penicillin concentration curves generally sigmoid in shape, with broth penicillin concentrations from 0·05 Oxford units per ml. to nil. Frequently, however, we have observed that tubes containing 0·005 U./ml., and sometimes 0·01 U./ml., have shown significantly more turbidity than those containing no penicillin. This effect appeared inconsistently when the incubation temperature was 37° C. At that temperature it has been noted after 4–24 hours of incubation, with a staphylococcal inoculum of between one and ten million per ml. broth, and with different samples of commercial sodium penicillin assaying from 84–820 units per mgm. It occurred in nutrient broth containing 'Marmite' and 0·1 per cent glucose, and in 10 per cent horse serum broth without the addition of sugar. In a preliminary investigation of this phenomenon we have been unable to define the exact conditions necessary for its occurrence at 37° C., but the amount of bacterial inoculum and duration of subsequent incubation are certainly concerned; whereas the pH of the medium, age of inoculum, the order of mixing and initial temperatures of the various reagents in the test, within certain limits, are not critical.

We have been able to study this phenomenon more easily by incubation at temperatures below 37° C. It may be consistently reproduced by overnight (16 hr.) incubation at 24° C. of 20 ml. amounts of nutrient broth containing 'Marmite' and dextrose (0·1 per cent), with an inoculum of approximately 5,000,000 cocci per ml., from a 24-hour broth culture. Under these conditions a well-marked growth-stimulating effect has been repeatedly obtained with penicillin concentrations in the broth of about 0·01 Oxford units per ml., as shown in the accompanying graph from an actual test. The addition of p-aminobenzoic acid (5 mgm. per 100 ml.) to the medium makes no qualitative difference to the result, nor does the addition of 10 per cent horse serum.

The increased turbidity is not due to mere enlargement or distortion of the individual cocci[4]. The organisms from tubes at the peak of the curve (containing growth-stimulating dilutions of penicillin) are morphologically indistinguishable from those containing no penicillin. In fact, plate counts have provided unequivocal evidence that there may be twice as many viable bacteria in the penicillin growth-stimulated cultures as in controls containing no penicillin. That this observation is caused by impurities seems unlikely in view of consistent reproducibility of the effect with pure crystalline penicillin: significant increases in turbidity over penicillinless controls can be obtained with as little as 0·0006 micrograms per ml.

Apart from recording the participation of penicillin in a rather general biological phenomenon, the object of this communication is to direct attention to the accumulating empirical evidence of the similarity of penicillin and sulphonamide action. So far as we are aware, the only commonly held conception of the mode of action of penicillin is that it acts bacteriostatically by preventing division of growing cells. This is based on Gardner's observation that bacteria subjected to concentrations of penicillin too small to inhibit growth completely undergo distortion and enlargement[4]. Analogous morphological changes are frequently associated with sulphonamide action. It has been further proposed that penicillin acts only on dividing bacteria[5], and that this action is bactericidal[6]. One of the final conclusions reached by Henry, in a very comprehensive review of the mode of action of sulphonamides, is that they achieve their effect by stopping cell division[7]. In general, the antibacterial action of both penicillin and sulphonamides, *in vitro* and *in vivo*, appears to be primarily 'bacteriostatic'. Under certain experimental conditions, however, penicillin[6,8], like sulphonamides, may exert a 'bactericidal' effect. Confusion



TURBIDITY-PENICILLIN CONCENTRATION CURVE.
Staphylococcal broth after 16 hr incubation at 24° C The concentrations lower than 0·01 U./ml. are 0 008, 0 006, 0 004, 0·002 and 0·001 U /ml. respectively. Test in duplicate.

is caused by drawing too fine a distinction between these terms.

The fundamental antibacterial action of penicillin and sulphonamides is inhibition of cell multiplication. Sulphonamides inhibit the growth of almost every variety of cell besides bacteria, although in widely varying concentration; there is as yet little evidence that penicillin will have such a general effect, but Cornman has reported survival of normal cells in penicillin solutions lethal to malignant cells[9]. Sulphonamide action is usually biphasic; our observations suggest that this may be true of penicillin. Primary bacterial proliferation preceding bacteriostasis, as occurs with sulphonamides, has recently been noted with penicillin and *Leptospira icterohæmorrhagiæ*[10]. (As mentioned previously, this may well be another aspect of the biphasic phenomenon.) Penicillin growth-inhibition, in conformity with that of sulphonamides, appears to obey the law of mass action, in that (*a*) the inhibition is reversible, by removing the bacteria from contact with penicillin or destroying the penicillin with penicillinase, and (*b*) the inhibition is directly related to the penicillin concentration[3]. Both penicillin[6,8] and sulphonamide activity are directly related to the temperature. In the presence of a constant amount of sulphonamide, antibacterial activity is inversely related to the number of organisms present; this is a phenomenon which awaits satisfactory explanation; and the explanation is also required in respect of penicillin[6]. A feature of sulphonamide activity is that it varies from one bacterial species to another, from strain to strain, and even perhaps from organism to organism. Penicillin exemplifies this selectivity *par excellence*. Antibacterial effect is greatly influenced by the sulphonamide chemical structure, and scientific progress with penicillin must be seriously impeded until its structure is made known. By analogy, however, there is every reason to expect that substances chemically related to penicillin will have different bacterial 'spectra'. Chemical information is also lacking for a comparison of the effect of *p*H changes on penicillin action; at present this factor appears more important to sulphonamide action. Organisms can be trained to resist either penicillin or sulphonamides to a surprising degree, and with almost equal ease. Penicillin shares with sulphonamides synergism of antibacterial effect by antibodies and cellular defence mechanisms.

The commonly accepted theory of sulphonamide action, that of Woods and Fildes, casts *p*-aminobenzoic acid in an essential role[11]. Since this substance plays no similar part in penicillin action, some fundamental difference in mode of action might be presumed. But Henry's conclusions throw considerable doubt on the Woods-Fildes explanation, and reconcile this apparent anomaly in sulphonamide-penicillin similarity[7]. There appears to be general agreement that sulphonamide bacteriostasis is achieved by direct inhibition of one or more enzymes. The profound biological activity shown by penicillin in trace concentrations would appear to be eminently explicable in terms of enzymic phenomena. It is not our purpose, however, to speculate on the mode of action of penicillin; but to suggest, on the basis of empirical observations available now, that it is not likely to be fundamentally unique. The differences that do exist between sulphonamides and penicillin, and which place the latter in its pre-eminent therapeutic position, appear to be differences of degree so far as mode of action is concerned.

Much of the technical work on which our observations are based was performed by laboratory assistants in the Royal Navy, to whom we are indebted. The crystalline penicillin was generously given by I.C.(P.), Ltd.

Addendum. Additional information has become available since this communication was written. It is now clear that at least three chemically different varieties of penicillin have already been identified and that their relative efficiencies for various bacteria are probably different[12]. The effect of *p*H on penicillin activity[13] is, in fact, in striking conformity with what has been reported for sulphonamides. The direct relationship of temperature to penicillin activity has been amplified[13,14]. Todd[15] has demonstrated the frequency with which primary multiplication occurs in cultures subjected to the influence of penicillin, and noted that Fleming originally reported this phenomenon in 1929.

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[6] Bigger, J. W., *Lancet*, ii, 497 (1944).

[7] Henry, R. J., *Bact. Rev.*, **7**, 175 (1943).

[8] Garrod, L. P., *Lancet*, ii, 673 (1944).

[9] Cornman, I., *Science*, **99**, 247 (1944).

[10] Alston, J. M., and Broom, J. C., *Brit. Med. J.*, **2**, 718 (1944).

[11] Woods, D. D., and Fildes, P., *Chem. and Ind.*, **59**, 133 (1940).

[12] See *Nature*, **154**, 725 (1944).

[13] Garrod, *Brit. Med. J.*, i, 107 (1945).

[14] Eagle and Musselman, *J. Exp. Med.*, **80**, 493 (1944).

[15] *Lancet*, i, 74 (1945).

CONFERENCE ON AUDIO-VISUAL EDUCATION

AUDIO-VISUAL education and the part it must play in the schools of Hertfordshire were discussed at a whole-day conference held at Welwyn St. Mary's C.E. School on February 2.

Opening the Conference, Mr. A. R. Chorlton, deputy education officer for the county, who has done much to foster an interest in this aspect of education, commented upon the suitable atmosphere for the subject under discussion created by a set of artist's originals for a series of coloured lithographic posters dealing with the Industrial Revolution, brought for the occasion by Lieut.-Commdr. Rawnsley, of Common Ground, Ltd., and the various optical instruments and demonstration material provided by Metalair, Dufay Chromex, and a Hertfordshire school which has been specializing in audio-visual education. The Conference, he said, was the outcome of work done during the past eighteen months by the Watford and District Audio-Visual Education Association and the North Herts Visual Aids Committee. Its object was to enable members of both Committees to meet and discuss a plan of action for the ensuing year.

In the absence of Mr. G. Patrick Meredith, lecturer in visual education, University College, Exeter, who

was to have addressed the meeting, Commander Rawnsley opened the discussion on visual material and media by outlining the objects of experiments he had conducted in this field in order to provide suitable material in the form of background posters, classroom exhibitions, film-strips and films. He stressed the need for integrating means and material in order to produce a living situation, and argued that only thus can a child be truly educated to become a useful member of the community. To do this, teachers will have to become attuned to the visual education approach. The value of Commander Rawnsley's contribution was emphasized by the excellent teaching quality of the film-strip and film on coal, edited under the guidance of J. Fairgrieve, which complemented the exhibition.

The afternoon session was opened by Mr. A. Arkinstall, headmaster of Callow Land Boys' School, Watford. His subject was "Essentials for a Successful Audio-Visual Aids Programme". Commencing with the child—for that, he felt, is where we should start if we are to have ultimate success with any project which concerns the child—he outlined the educational pattern which must be completed if his audio-visual needs are to be met. A better understanding of the dull and backward child's point of view and environment, coupled with an education which has a good audio-visual content, would do much to reduce juvenile delinquency. In the immediate future, we should collect as much information as possible to help to put audio-visual education on a sound psychological basis. The teacher has great opportunities in this connexion. Experiments should be conducted on research lines organized by committees of local associations, and the findings passed on to the university research departments. He envisaged the time when each county would have a central clearing-house in contact on one hand with the B.B.C., Federation of British Industries, museums, Ministry of Education, local education authorities, authors (for copyright permits), university research centres, and producers of audio-visual means and material; and on the other with audio-visual associations, head teachers, training colleges, adult education centres and youth movement leaders.

At the present time schools are ill-equipped for audio-visual education; apparatus such as wireless receivers, film-strip and film projectors, gramophones and records, together with plenty of good pictures in good sequences, all approved by teachers for quality in a teaching situation, are needed for use in rooms suitably equipped for such instructional means. Despite present shortcomings, the best use must be made of such material and means as are available in order to show by the results of one or two pieces of research work that this is a worthwhile project upon which money would be well spent.

This suggestion was followed by Mr. H. Goldsmith, one of the Ministry of Education inspectors, who gave an account of the conditions of loan to the county of a number of American strip-film projectors, each accompanied by fifty strips dealing with various aspects of life in America. He hoped that part of the research proposed would be in connexion with the evaluation of this material.

A particular feature of the Conference was the practical nature of the suggestions put forward by those contributing to the discussions in both sessions, but perhaps this was to be expected when their interest in the apparatus and material which surrounded them on all sides is considered.

MANGROVES IN THE NEW WORLD

MANGROVES have been of interest to botanists ever since the first details were given by morphologists in the eighteenth century, not only to specialists in ecology on account of their somewhat peculiar distribution as shore-line vegetation, but also to the general botanist in view of the unusual morphological and physiological features which they display It is therefore satisfactory that it has been found possible to give a very full account of the main features of these plants as observed by the 1939 Cambridge Expedition to Jamaica[1]. Those of us who have attempted field experiments even a short distance from the laboratory will realize full well the difficulty in assessing requirements beforehand, and it can well be understood that the performance of the Expedition falls short of its members' expectations on this account and in view of the scanty data already in the literature on which they had to rely for guidance Nevertheless, in spite of these unavoidable difficulties and notwithstanding the cessation of activity due to the outbreak of war, Dr. Chapman presents a most impressive series of three articles ranging over a wide field of endeavour. It is stimulating to find here a clear grasp of the problems involved in attempting to relate morphological character to physiological function, with repeated emphasis on the problems yet to be solved. Work of this kind can clearly not be final, and probably the most useful feature of the Expedition, as it is reflected in these papers, lies in the guidance it gives for more detailed investigation which may become possible in the future.

The first paper surveys the botanical processes involved in the maintenance and development of the shore-line in Jamaica, and discusses the distribution and ecological significance of the range of mangroves and associated plants found on the island. In the second and third, Dr. Chapman concentrates on one particular species (*Avicennia nitida* Jacq.) from the point of view of its relation to its environment, its morphology, and the physiological peculiarities associated with pneumatophores.

It comes somewhat as a surprise to the uninitiated to realize the comparatively wide tolerance of mangroves to soil conditions. Here we have soils ranging from sand to mud well populated, with salinity of soil water ranging over wide limits even up to fresh water in isolated cases. It is impossible in a short space to consider the vast amount of information presented in any detail; but it may be said in general that the drift in dune development resembles in broad outline that found in the British Isles and that the mangroves of the New World as found in Jamaica come under the "wide salt tolerance" class into which Schimper put some of the Old World species. Details of species and probable origin are given, and the brief discussion of the migration of seeds and seedlings along ocean currents, and the effects of fresh water at river estuaries, surely forms one of the most fascinating stories in all nature study.

In the second paper an attempt is made to elucidate the edaphic factors important in the growth of this mangrove, which shows optimum growth in soils with more than 0·5 per cent sodium chloride where the water content either does not fall below a certain minimum or is replenished periodically by flooding. Oxygen content is not thought to play any important part in zonation, partly because the root system has

a comparatively thick bark which may be impervious to gases, and the role of sodium chloride is doubtful. It is probable that a number of factors—winter temperature, ocean currents, tidal inundation, soil accretion, mechanical composition of soil, exchangeable base and the behaviour of the water table—are all important collectively. Soil conditions vary over relatively narrow limits. Soil *p*H varies from about 6 to about 8 over the soil types populated and the water-table fluctuates through only two to three inches. This latter is particularly important, for it means that the horizontal roots and the pneumatophores are above the water-table for considerable periods, and we must abandon the idea that mangrove roots must be bathed in water continually. In the soil water the oxygen content is well below the atmospheric percentage, but carbon dioxide is on the whole higher, and this therefore lends colour to the widely accepted belief in the function of the pneumatophores in aeration. The Na^+ and Cl^- contents of soil water and of plants are presented at some length, but unfortunately the statements made in this part of the paper lose much of their force as the basis upon which the percentages are given is not clearly defined.

The third paper gives a very welcome and admirably thorough description of the developmental morphology of *A. nitida* from the young seedling to the mature plant, profusely illustrated by line drawings in some of which, however, it is not always easy to pick out the details referred to in the text. Secondary thickening appears to varying extents in almost all the organs of the plant, and it is particularly interesting that, so far as one can judge from the data presented, thickening begins in the roots before it does in the stems (though this is not, in fact, specifically stated). The pneumatophores (which are said to be negatively geotropic, but may, as Dr. Chapman points out, be positively aerotropic) may be some 35 cm. high by about 8–10 mm. thick, with well-formed lenticels in the above-ground portion. The cortex has numerous large longitudinal air spaces, as has also the corresponding tissue in the horizontal roots from which the pneumatophores arise, but the two systems are apparently separated by a more solid tissue at the base of the pneumatophores. Movement of gases from pneumatophore to horizontal roots must therefore occur by diffusion and not by mass flow. The gas in these air spaces is very much like that in the atmosphere and very different from that found in the soil water. Experimental work shows that of the carbon dioxide exhaled by a pneumatophore, about 50 per cent may come from the respiration of the pneumatophore itself (a figure which should apparently be in fact much higher, since in the experiments the air spaces in the horizontal roots were replaced by an atmosphere containing 10 per cent carbon dioxide applied to the lower end of the pneumatophore from cylinders prepared in advance in Britain; this carbon dioxide content is much larger than that actually found in the air spaces). The respiratory function of the pneumatophore itself must therefore not be overlooked. Further, as Chapman also emphasizes, the pneumatophores carry absorbing rootlets near the soil surface and as soil accretion occurs, these rootlets appear higher up the pneumatophore and therefore nearer the new soil surface. A further important function of the pneumatophores may therefore be the maintenance of a functional absorbing root system.

Dr. Chapman makes it abundantly clear that mangroves will repay intensive study by morphologists, physiologists, geneticists, biochemists and even students of cell-wall problems. In this latter regard, some of the cells in pneumatophores bear peculiar internal buttresses growing into the cell from the wall and recalling the trabeculæ found in the tracheids of some conifers and similar structures in marine algæ like *Caulerpa*. These idioblasts, as they may be called, would repay study. All the papers include a very full bibliography and a careful comparison of the writer's work point by point with that of earlier workers in the field, and this makes them, indeed, a veritable compendium of mangrove-lore.

R. D. PRESTON.

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EFFECTS OF HEAT ON HUMAN BEINGS

AN interesting series of physiological and clinical observations on the effect of the desert climate of Shaiba, southern Iraq, in the summer of 1943, has been reported by W. S. S Ladell, J. C. Waterlow and M. F. Hudson (*Lancet*, 491, Oct. 14 and 527, Oct. 21, 1944). Both fit soldiers and cases of the effects of heat were studied. All the fit men lost some weight in the hot weather, especially those who had the highest chloride concentration in their sweat. The measured rate of sweating and the estimated salt intake indicated that subjects with a high concentration of chloride in their sweat (more than 0·3 per cent of sodium chloride) may not always have been in salt balance. Low output of urine, in spite of high water intake, low urinary chloride and raised blood urea, suggested salt-deficiency dehydration.

Twelve cases of hyperpyrexia are recorded and two types of heat exhaustion. The first type occurs, it is suggested, in persons who secrete sweat containing much higher chloride concentrations than the average; their salt intake is insufficient and they become salt-deficient; extra salt might prevent the occurrence of heat exhaustion in these persons. The second type was seen only in the second half of the summer in men unaffected by the heat of the first half; prickly heat accompanied the heat exhaustion, but this type did not have the vomiting and cramps suffered by the first type. The condition of the second type suggested a breakdown of the body's defences against heat. There was salt-deficiency, but no dehydration. It would be worth while to inquire whether the concentration of salt, or of other constituents of the sweat, or the influence of other factors controlling its secretion, could be related in any way to the well-known variations in susceptibility to the bites of mosquitoes and other biting arthropoda.

Following this article, D. H. G. MacQuaide describes (*Lancet*, 531, Oct. 21, 1944) two cases of congenital absence of the sweat glands. Both had to be classified as totally unfit for service in the tropics. The author adds an interesting note on the literature relating to congenital ectodermal defects. These include an idrotic group, which is mostly a hair and nail dystrophy found in both sexes and transmitted by either, and an anidrotic group, found mostly in males and probably transmitted by a maternal carrier; in this latter group are absence of the sweat glands and occasionally of the sebaceous glands, dental dysplasia and other conditions of the nose, skin and hair. No cases belonging to this group are known in Negroes or Latin races. G. LAPAGE.

FORTHCOMING EVENTS

Saturday, February 17

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Institution, Albemarle Street, London, W 1), at 2 30 p m.—Dr R E Slade "The Organisation of Research in Industry".

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2 30 p m — Lieut -Colonel H E B Daniell and Mr L H Forster "Successful Operation of Two-Stage Air-Cooled Inbye-Compressor", Mr R. Williams, Mr. W Jeffery and Mr A Taylor "Outbursts of Gas from the Floor of Coal Seams, Part 2".

Saturday, February 17—Sunday, February 18

ASSOCIATION OF SCIENTIFIC WORKERS (at Caxton Hall, Westminster, London, S W 1)—Conference on "Science in Peace".

Saturday, February 17

At 2 15 p m —"Science and Production" (Chairman · Prof P M S Blackett, F R S.)

Sunday, February 18

At 10 a m —"The Future Development of Science" (Chairman Sir Robert Watson-Watt, F R S.)

At 2 30 p m —"Science in Everyday Life" (Chairman Prof H. Levy)

Monday, February 19

IRON AND STEEL INSTITUTE (joint meeting with the CLEVELAND INSTITUTION OF ENGINEERS) (at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough), at 6 30 p m —Mr G D Elliot "Ironmaking at the Appleby-Frodingham Works of the United Steel Companies, Limited"

Tuesday, February 20

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W C 2), at 1 45 p m.—Sir Edmund O Teale "The Contribution of Geological Survey to the Development of the Mineral and other Resources of East and West Africa".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m —Sir George Dyson "The Origin and Development of Early Musical Forms", (2) "Purcell and Couperin".

ROYAL STATISTICAL SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 5.15 p m —Mr H. Leak and Mr A. Maizels. "The Structure of British Industry"

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p m.—Dr H. Chatley : "Dredging Machinery".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m —Discussion on "Aspects of Post-War Valve Standardization" (to be opened by Mr. A. H Cooper).

Wednesday, February 21

BRITISH SOCIETY OF ANIMAL PRODUCTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 10 30 a.m.—Discussion on "Meat". At 11.15 a.m —Major W H. Warman and Mr. R. W Pomeroy "Supplies"; at 2 p.m —Dr. E H. Callow · "Food Value, Quality and Grading of Meat with special reference to Beef"; at 3 15 p.m.—Mr. T. Shaw · "Marketing and Distribution".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2 p m —Discussion on "The Veterinary and Medical Control of the Milk Supply" (to be opened by Mr. H T. Matthews (Veterinary), Dr. W. A. Lethem (Medical) and Mr Clyde Higgs (Agricultural).)

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 30 p m.—Mr. E. M Bennett "The Classification of Inventions disclosed in United Kingdom Patents Specifications"; Mr. H Rottenburg : "Towards a Revision of the Engineering Section of the Universal Decimal Classification".

Thursday, February 22

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W.1), at 2.30 p m.—"The Land's End and Beyond" (a colour-film with commentary by Mr John Chear); Mr Paul de Laszlo · "Colour Photography as applied to Biology", "Ethiopia" (a colour-film with commentary by Mr. H G. Hope Gill).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p m —Prof. James Gray, F R.S · "Locomotory Mechanisms in Vertebrate Animals", (4) "Nervous Control of Movement".

Friday, February 23

INSTITUTE OF FUEL (joint meeting with the NATIONAL SMOKE ABATEMENT SOCIETY) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C.2), at 10 a.m —Conference on "Post-War Smoke Abatement" Dr. G. M B Dobson, F R.S · "A Statement of the Problem", Major S. F. Markham, M.P. · "The Effects on Civilisation of Atmospheric Pollution", Mr A. Blackie "Domestic Smoke"; Mr. M. G. Bennett "Railway Smoke"

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 4 30 p m —Prof. Robert Debré (Professor of Pediatrics in Paris) "Conditions of Children in France under the Occupation".

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S W.7), at 5 p m — Mr. F. W Cuckow "The Electron Microscope and its Applications".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p m —Prof. Benjamin Farrington "The Character of Early Greek Science".

Saturday, February 24

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S W 1), at 2 30 p m —Mr D R Barber and Mr E H Amstein "Factors Influencing the Choice of Photographic Materials for Use in Quantitative Spectrography"

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St James's Park, London, S W 1), at 3 30 p m — Mr N Hanlon "The Problems involved in the Establishment of a Large Works in a Country District"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

ASSISTANT MUNICIPAL ENGINEER by the Accra Town Council, Gold Coast—The Ministry of Labour and National Service, Appointments Department, Central (T and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No E 1174 A) (February 22)

ASSISTANT ELECTRICAL ENGINEER for Colliery Power-House Overseas (India)—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No D.1023 XA) (February 22)

TEACHER (resident, certificated, graduate or non-graduate) of GENERAL SCIENCE (preferably including AGRICULTURAL SCIENCE) in the Junior Technical School in Agriculture, Pibwrlwyd—The Director of Education, County Education Offices, County Hall, The Castle, Carmarthen (February 24)

CHEMIST (Metallurgist) for large engineering factory on North-East Coast—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3385 A) (February 24)

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Principal, Mining and Technical College, Church Street, Barnsley (February 24)

SENIOR and highly qualified MECHANICAL ENGINEER with specialized up-to-date knowledge of the Design and Operation of Large Steam Turbines and/or Boilers for highly efficient steam cycles—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No C 2467 XA) (February 26)

MECHANICAL ENGINEER (resident) to supervise the installation of Boiler, Turbine and other Plant in a 100,000 kW Station now under construction (Reference No C 2468 XA), and several ASSISTANT MECHANICAL ENGINEERS and ASSISTANT ELECTRICAL ENGINEERS with experience in the Design, Specification and Construction of Power Station Plant (Reference No C.2469 XA)—The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting the appropriate Reference No) (February 27).

CIVIL ENGINEERS (4) for the duties of ASSISTANT DIVISIONAL ENGINEER in the Irrigation Department of the Sudan Government—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No E 1376 A) (February 27).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS, and a TEACHER OF ELECTRICAL ENGINEERING SUBJECTS—The Principal, Southall Technical College, Beaconsfield, Southall, Mddx. (February 28)

CHEMISTS in the Directorate of Food Inspection in India—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3592 A) (March 1)

CHIEF SUPERINTENDENT in a Government establishment concerned with the development of Army Radar—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No D 1082 A) (March 3).

ENGINEER to take charge of all ENGINEERING and ASSOCIATED SERVICES in large old-established Works in North Midlands area—The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. C 2453 XA) (March 6).

LECTURER IN ELECTRICAL ENGINEERING, to teach Day and Evening Students for London External B Sc (Eng) and for Ordinary and Higher National Certificates in Electrical Engineering in the Norwich City College and Art School—The Director of Education, City Hall, Norwich (March 9)

ENGINEER for position of Personal Assistant to the Chief Engineer of a large iron and steelworks combine in the North of England—The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No C 2452 XA) (March 12).

RESEARCH ENGINEER immediately to organize and control Laboratory and Experimental Department of progressive manufacturing Company situated in N W. London area—The Ministry of Labour and National Service, Appointments Department, Central (T and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No C.2462 XA) (March 12).

PRINCIPAL OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE, Wye—The Clerk to the Governors, 11 Bank Street, Ashford, Kent (March 19).

LABORATORY ASSISTANT IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N W 1

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Technical College, Brunswick Road, Gloucester.

CROP RECORDER at Sub-stations in Shropshire and Northumberland—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

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SELECTION FOR HIGHER APPOINTMENTS

THE importance of efficient management has been much discussed during the past few months, a recent reference being the address by Mr. W. C. Devereux, of High Duty Alloys, Ltd., at the British Association conference on "The Place of Science in Industry" (see *Nature*, January 29, p. 96). The report of the Higher Appointments Committee set up by the Minister of Labour and National Service in July 1943 was therefore awaited with unusual interest*. The Committee, of which Lord Hankey was chairman, was appointed to consider and report upon the arrangements which should be made to facilitate the employment after the end of hostilities of men and women qualified to undertake responsible work in the professions or elsewhere, with particular reference to (*a*) the organization, premises and staff of the Appointments Department of the Ministry of Labour and National Service, and (*b*) the arrangements which should be made for co-operation between the Appointments Department and other organizations and institutions and universities, in Great Britain and abroad. It is thus of fundamental importance with respect to the re-allocation of employment involved in demobilization, though it was not one of the functions of the Committee to consider the quantitative aspects or trends of employment : that is one of the functions of the Interdepartmental Standing Committee on Education and Training, appointed at the same time as the Higher Appointments Committee, and with the same chairman and secretariat, primarily to consider and report on employment prospects in the various professions and callings. Despite this limitation, the present report is an important contribution to the discussion of a subject which was freely ventilated in the papers contributed recently by Sir Ernest Simon, Dr. C. P. Snow and Sir Lawrence Bragg in a recent number of the *Political Quarterly* dealing with the future of the universities, and the report is as emphatic as those papers that attention to this quantitative aspect is a primary condition for the efficient functioning of any appointments department.

The Appointments Department of the Ministry of Labour and National Service was itself an outcome of experience with the Central Register, and the report includes a review of the work of the Department and of the Central Register, supplementing the review which appeared three years ago in the sixteenth report of the Select Committee on National Expenditure for the 1941–42 Session (see *Nature*, 150, 733 ; 1942). Before proceeding to this review, the present report emphasizes the general approach of the Committee to the problem, which is essentially that of making sure, in the interests of the country as a whole, that full and proper use is made in the future of its greatest single asset, the trained ability and intelligence of its men and women. The wisdom of that approach was emphatically supported

* Higher Appointments: Report of the Committee appointed by the Minister of Labour and National Service in July 1943. (Cmd. 6576.) Pp. 62. (London: H.M. Stationery Office, 1945.) 1*s*. net

at the British Association Conference on "The Place of Science in Industry" referred to above, which, while providing evidence that Great Britain has at its disposal resources of ability and intelligence second to none, showed that in certain fields those resources are quantitatively far short of what is required.

The Committee concludes first that the effort or enterprise of private organizations with their sectional, geographical and often financial limitations cannot provide all the machinery: direct provision by the State is indispensable. Accordingly, the Committee's recommendations provide in some detail for the organization of a national agency for higher appointments. While most of the recommendations relate to this question, the Committee does not consider that the mere provision of an employment agency, however efficient, will by itself be enough. It regards the placing work of the Appointments Department as the focal point of a service for providing men and women and their employers with the best available information, advice and help. The Appointments Department must in fact carry out its task with the widest conception of the public service that can thereby be rendered, or it will not function at all.

With this conception of the practical task, the Committee stipulates three conditions of success. First, the organization must be such as to encourage all men and women within the field to use it. Secondly, it must have the skill and knowledge necessary to assess the ability, actual or potential, of the men and women with whom it deals, and to know the kind of job to which each is most suited, as well as the best advice to give where the choice of a career or training for a career is involved. Thirdly, it must command the confidence of employers, so that they will not only use it to the full and thus provide it with the maximum opportunity for finding jobs, but also be prepared to take an interest in it and help it in its work.

To achieve these aims, the organization must be planned on the right lines and then staffed with the right officers and, like Dr. C. P. Snow and also the earlier memorandum on graduate employment issued by the National Union of Students, the report stresses that in a human problem such as this the indispensable foundation of success is the appointment of the right men and women to tackle it. In the main, the report is concerned with the re-settlement period of four or five years after the War, and does not deal in detail with the ultimate shape of the Appointments Department. The Committee stresses, however, in regard to this question of staffing, that a very substantial proportion of the staff of the Department must, at the outset and throughout the re-settlement period, be drawn from outside the permanent Civil Service. There will be a unique opportunity at that time to obtain the services of men and women with suitable qualifications and experience who are leaving war service, either in Government departments or in the Fighting Services. While those permanent officials of the Ministry who are particularly well qualified for such work should be allotted to the Appointments Department so far as possible, there can be little doubt that among the remaining officials of the Department recruited from outside the permanent Civil Service will be found a number worthy and willing to continue as permanent officers

Reviewing next the present organization, the report points out that early in the War it became clear that the Central Register is divided sharply into two categories. The demand for those in the first, comprising engineers, scientific workers, etc., was much greater than the supply; while for those in the second, comprising persons with administrative, executive and business qualifications, the exact reverse obtained, and with the supply of such persons increasing with the reduction or closing down of industrial and commercial undertakings, the Central Register proved an unsatisfactory instrument for dealing with persons in this category. The Appointments Register under the new Appointments Department, which began to operate in March 1942, was created to meet this difficulty. The Supplementary Register was abolished, and new decentralized arrangements made for dealing with this second category. The Appointments Branch has thirty-one offices throughout Great Britain and deals not only with all persons other than engineers, scientific workers, and the like who possess higher qualifications, but also with those who fall below the standard required for enrolment on the Central (Technical and Scientific) Register.

The work done by the Appointments Department for private employers has steadily increased, and the Department is already seeking to provide the kind of service which it will have to give on a larger scale after the War. While the work of the Appointments Department has been decentralized, that of the Central (Technical and Scientific) Register, meeting a national rather than a local need, remains centralized. Technical officers were appointed in September 1940 to the five technical sections of the Register, and there are six advisory committees serving architecture and public utilities, chemistry, civil engineering, electrical engineering, mechanical engineering, and scientific research.

Pointing out that the area covered by each employment exchange is far too small for dealing with higher appointments, in which both applicants and vacancies require far more individual attention, the Committee proposes that the appointment offices should form part of the regional organization of the Ministry of Labour, with the exception of the London Appointments Office, which should continue as part of the headquarters of the Ministry. The line of demarcation between appointment offices and employment exchanges should remain just above the level of foreman and clerk. Demarcation by grade and by the level of remuneration are rejected, as is the drawing of a special line of demarcation for each profession or section of industry or commerce. Demarcation by remuneration, for example, would be liable to exclude beginners in many professions and thus deprive the Appointments Department of one of its most important functions.

The number of appointment offices should be as

small as possible, so as to secure a large area and greater prospects of filling vacancies from those on its own register, and to facilitate the employment of more specialized and expert staff. Not more than fifteen offices are recommended, to be situated in London, Southampton, Bristol, Cambridge, Birmingham, Nottingham, Leeds, Manchester, Liverpool, Newcastle-on-Tyne, Edinburgh, Glasgow and Cardiff, with local representatives of the Department in perhaps sixty or more other centres. The areas of these offices should be settled solely with reference to the requirements of the work.

Arrangements for pooling applicants between appointment offices are necessary, and the present system of circulating particulars of vacancies should continue, while particulars of any vacancy for which it appears unlikely that an appointments office can submit really suitable candidates should immediately be circulated to the other offices. Particulars of vacancies of the highest type should be sent to the London Appointments Office, which should be responsible for filling them. Arrangements are recommended for handling centrally vacancies which are likely to be filled by engineers with full professional qualifications and applicants who are likely to be acceptable for such vacancies. Vacancies for scientific workers of any type for which the market is essentially a national market, for example, physicists and biologists, should be dealt with centrally, and where an occupation is handled wholly or partly at the centre, officers possessing high academic and professional qualifications should be employed upon the work. Moreover, since those who possess high professional qualifications are not always employed in a professional capacity, to avoid any undue separation between the work of the Appointments Department in respect of such occupations and the general work, the Committee recommends that the branch dealing with occupations wholly or partly decentralized should form part of the London Appointments Office.

An admirable survey of the work of the appointments office and of the advisory service provides ample evidence of the valuable contribution which such an office and service, properly staffed and run, might make to the effective use of scientific and technical man-power. The Appointments Department, for example, should be well placed to make available to the public information about trends of employment and particulars regarding the various occupations which are rarely available to the university appointments boards, and its advice upon the choice of a career should be based upon the guidance of the Interdepartmental Standing Committee on Further Education and Training. Another suggestion in the report in the same field is the issue of broadsheets dealing with the employment situation.

One of the most important sections of the report is that which deals with public relations and co-operation with other organizations. Leaving on one side the detailed recommendations for bringing the services offered by the Appointments Department to the notice of the general public and in particular to the members of the Forces, the scientific worker will be especially concerned with the measures proposed for interesting professional, commercial and industrial organizations in the area of each appointments office. This is of special importance not merely because many centres are without an appointments office, but also because it is not intended that the new organization should have a monopoly in the work of filling higher appointments. It is intended rather to design an organization which will be used purely on its merits, and accordingly its relation to the existing appointments bureaux of such professional bodies as the Royal Institute of Chemistry and the British Association of Chemists, or the Professional Engineers' Appointments Bureau, which the Institutions of Mechanical, Electrical and Civil Engineers are proposing to establish to assist the re-settlement of engineers after the war, in co-operation with the Ministry of Labour, may be of vital importance.

The recommendations of the report in this connexion are straightforward. First, every appointments office should have a development section devoted to this work, and while local advisory committees are not suggested, it should be a primary duty of the officer in charge of each appointments office to take all appropriate steps to secure the friendly interest of all persons and organizations in the area covered by the office whose co-operation will conduce to success, and to establish relations with knowledgeable persons, including officials of professional institutions, with the view of their giving advice on subjects on which they are experts and expert assistance in exceptional cases, such as interviewing an applicant whose case presents special problems. On the other hand, in view of the experience of the advisory committee of the Department during the War, the Committee recommends that there should be national standing advisory committees representative of the principal professions and occupations, meetings of which can be called when advice or assistance is desired by the headquarters of the Appointments Department. While the Committee holds that the Appointments Department must be responsible for submitting to the employer the best possible list of candidates for any vacancy, subject to this paramount principle, it wishes to see co-operation with other employment agencies, such as the university appointments boards and professional institutions which operate in this field, developed to the highest degree.

Special consideration is given in the report to the university appointments boards, and the Committee considers that the registration of graduates with the appointments offices as well as with the university appointments boards would both assist employers to make full use of men and women with university training and also widen the opportunities for employment of graduates. Concrete suggestions as to the form which such co-operation might take are included in the report, and their adoption might go far to meet some of the criticism of university appointments boards to be found in the National Union of Students' report "Graduate Employment",

as well as in "Redbrick University" and in Dr. Snow's recent article in the *Political Quarterly*. It will be noted that in fact the report provides for two of the three practical steps emphasized as necessary by Dr. Snow: a standing Government committee to report at least once each year on trends in employment of graduates; and that the Appointments Department of the Ministry of Labour should act in close touch with this standing committee and have as its essential task the diffusion of information to undergraduates.

There can be little doubt that a Government department would be much better equipped to discharge such responsibilities as those which the National Union of Students suggests should be entrusted to the university appointments boards. Furthermore, the observations on the staffing of the appointments offices have a close bearing on the staffing of university appointments boards, and if the latter are, as Dr. Snow suggests as the third step, strengthened in the large universities on the Cambridge scale and developed on tutorial lines in the smaller universities, their effectiveness cannot fail to be increased by contact and co-operation with a Government Appointments Department staffed as advocated in this report.

There is a further point with regard to co-operation with the professional institutions which are active in this field. Some of them have old-established and efficient appointments bureaux and may tend to look askance at a new Government agency, at least until it has gained their confidence by good work. The report, which establishes beyond question the need for a national organization, should equally dispose of any fears as to competition and rivalry. What is required is in fact complete and friendly co-operation—a co-ordinated effort to ensure the best possible use of the specialized knowledge and ability which constitute one of the most precious assets of Great Britain. It may well be that one consequence will be some diminution, if not elimination, of overlapping activities in this field on the part of rival professional organizations. The engineers are clearly moving in this direction. Even more fundamentally, it is a reminder that the functions and duties of professional associations change, and that, as Prof. H. Laski has pointed out, in a new age of full employment, their protective and defensive functions may have less meaning and importance, while other duties increasingly invite their zeal and service.

UNIVERSITY GRANTS IN GREAT BRITAIN

SIR JOHN ANDERSON'S statement in the House of Commons on the Treasury grants to be made available to the universities and university colleges of Great Britain during the next few years must have come as a great relief to those who are responsible for the finances of these institutions, for the recurrent grant for general university purposes is to be nearly doubled by an addition of £2,000,000 in each of the next two years, and there is to be a further grant of £1,000,000 for developments in the medical schools arising out of the recommendations of the Inter-Departmental Committee's report, and £500,000 for grants to the teaching hospitals on the recommendation of the same committee. The grants for future years will be reviewed at the end of the two-year period. For capital expenditure, a token sum of £250,000 is to be made available to the University Grants Committee for distribution during the coming year. A sum of £5,900,000 in all will thus be included in the 1945 estimates as a grant in aid of the universities, colleges, medical schools, and teaching hospitals of Great Britain.

The Chancellor's statement is noteworthy not only because of the generous allocation of funds which it discloses, but also because of the evidence it affords of the receptiveness shown by him to the advice tendered by the representatives of the universities and university colleges, and by the University Grants Committee, which is charged with the duty of administering the grant.

The approximate doubling of the grant for general university purposes will, however, provide little more than is required for the long overdue increase in the salary scales of members of university staffs. An increased income of not less than £1,500,000 per annum is needed immediately to adjust these salaries to a level comparable with that prevailing in other professions which are recruited from students of similar training and standard of attainment. It is greatly to be hoped that the lead now given by the Government will be generously followed by local authorities, so that provision will be forthcoming to make university education available to the greatly increased numbers of students who will soon be seeking it. This will require an increase in the existing staffing of departments and a larger provision for maintenance charges of all kinds.

Sir John Anderson stated that in view of the restrictions on building which are likely to operate during the years immediately following the War, it seems unlikely that the universities will have opportunities for any considerable capital expenditure during the next year or two; but he added that if the grant of £250,000 for capital expenditure should prove insufficient, the possibility of its being increased within the financial year would not be ruled out. Capital expenditure is needed not only for the erection of new buildings but also, and more immediately, for the purchase of sites on which the new buildings can be erected. In many universities and colleges the need of funds for the acquiring of land, now available, is a matter of pressing urgency if the opportunity of expansion on to convenient sites is not to be permanently lost. It thus seems probable that the University Grants Committee will receive requests from the universities, during the present year, for a greater total sum than that provisionally allocated by the Chancellor to capital expenditure in 1945. It is obvious, for example, that £250,000 would not go very far towards providing the additional sites now urgently needed by the many colleges and institutions of the University of London alone.

Universities are rightly zealous in safeguarding their autonomy, and satisfaction will no doubt be derived from the fact that, in announcing the special grants for medical schools, the Chancellor did not threaten the imposition of financial sanctions, as did the Minister of Health in a reply he made in the House of Commons a few weeks ago. On that occasion, in a written reply relating to the report of the Inter-Departmental Committee on Medical Schools, Mr Willink indicated that the Government's acceptance of the principle of increased grants for medical education and research was dependent on a revision of the medical curriculum being carried out at an early date. Such a decision by the Government, taken without prior consultation with the university authorities, however well-founded it might be, would be a grave departure from established procedure and a menace to the academic freedom of the universities.

SCIENCE AND SALVAGE

Science and Salvage

From the German "Verwertung des Wertlosen". Editor, Claus Ungewitter. Translated by L. A. Ferney and G. Haim. Pp. 183. (London: Crosby Lockwood and Son, Ltd., 1944.) 12*s.* 6*d.*

WASTE, begotten of ignorance out of laziness, is no new phenomenon; it is probably coeval with man, if not with his progenitors. But primitive man had neither the knowledge and incentive nor the use of machines to convert his scrap into utilizable material; modern man has all these, but in general fails to apply them on any considerable scale, unless he is compelled thereto by war or by the expectation of profit. Modern industries based upon science have, however, not only realized the need of recovering materials hitherto wasted, but also they themselves have created new wastes to be recovered, such as chemical by-products and metallurgical scrap.

The words 'waste' and 'salvage' are sometimes used loosely. Strictly speaking, a waste material is one which might be recovered and re-used, with or without pre-treatment, but many, including the author(s) of the book under review, use them in connexion with low-grade minerals, with certain constituents of sea water, and even with certain atmospheric gases. Such raw materials, of actual or potential use, can scarcely be called 'waste', and the term should be restricted to substances and articles that have already been manipulated by man, either directly or by means of machines.

The German original of this book, entitled "Verwertung des Wertlosen" (utilization of the worthless), comprises a series of articles that appeared in *Die Chemische Industrie* shortly before the outbreak of the present War; they were published in book-form in 1938, with an introduction by Field Marshal Goering, and may therefore be taken as authoritative and up to date in regard to pre-war German practice, for most of the processes mentioned—few are described in detail—have either originated or been developed in Germany. The amount of work done there in this connexion can only be described as amazing; but, unfortunately, one cannot repress the thought that most of it was undertaken to render Germany as self-sufficing as possible and to build up the *Wehrmacht* with the ultimate object of attaining world domination. In 1939, Germany produced about 80 per cent of her food requirements and almost two-thirds of her industrial raw materials. If, in the future, she were cut off economically from the outside world, and were left with her present territory, it is quite possible that she might live on her own resources. Although starch-bearing tropical crops like rice and cassava could easily be dispensed with, luscious tropical and sub-tropical fruits, tea and coffee would have to go by the board, fats, oil, rubber and fibres could be made artificially, and cellulose in its various forms could be readily produced at home. Further, if metallurgical science continues to advance at its present rate, substitutes for some of the commoner metals and more particularly for certain rarer metals, like tungsten and molybdenum, would be forthcoming. Coal ash, as the authors point out, could supply appreciable quantities of zinc, arsenic, cobalt, nickel, molybdenum, chromium, vanadium, silver, gold, platinum and beryllium. National self-sufficiency in Germany and in many other countries is distinctly possible; but, as many will think, very undesirable in a peace-loving progressive world.

The wide range of subjects discussed in the book may be gleaned from the following abbreviated chapter headings: atmospheric gases, the sea, low-grade mineral resources, peat, forestal products, agricultural wastes, scrap and worn materials, municipal refuse, sewage, chemical by-products and coal ash. Few, if any, of the processes outlined will be unfamiliar to specialists, but even they will be interested in the efforts made in fields other than their own. It is to directors of large laboratories and research institutions, and not least to economists and 'business executives', that the book will make a special appeal. During the War of 1914–18, many patents for the recovery of waste were taken out, and but very few survived the ordeals of peace, the chief reason being that they did not 'pay'. Hence the future of scientific salvage will depend as much upon economic and political conditions as upon advances in science and technology. In certain cases it may well be advisable for Government or local authorities to assist in the initiation, development, and perhaps the operation of processes that may be deemed of primary importance, for it can scarcely be expected that public companies should risk their shareholders' money in such enterprises. Processes essential to public health and the national economy, like the treatment of sewage and of household refuse, would here come into the picture; and generally it may be postulated that public money should be used only for the provision of materials, etc., to meet basic needs, such as those used for food, power, clothing, shelter and communications. Apart from these, it may well be found that many of the ingenious processes evolved are inadvisable and redundant; for example, the recovery of materials that are renewed annually or at slightly longer periods by solar radiation.

Cupidity, ultra-nationalism and bad economics have in the past prevented many of the gifts bestowed by a bounteous Nature from becoming available to the people who need them. If nations could be made to realize, however slowly, by enlightened education that they are all members one of another, and if the fourth term of the Atlantic Charter, that all nations have free access, on equal terms, to the trade and to the raw materials of the world, could be implemented, much of the human effort that may be devoted to

the recovery of waste products could be saved, leaving more time and energy for devotion to constructive and creative work in science, art and letters.

A word of praise is due to the translators for having produced a good, readable version of the original which, if it conforms to type, bears the imprint of what Schopenhauer called the essentially German characteristic—ponderosity. E. H. TRIPP.

A PACIFIC SEAWEED FLORA

Marine Algæ of the Monterey Peninsula, California
By Prof. Gilbert M. Smith. Pp. ix+622 (98 plates). (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1944.) 36s. net.

IN most maritime countries there are certain stretches of the coast-line that offer peculiarly favourable conditions for the study of marine life. Such a one is the Monterey Peninsula in California, which is noted not only for the wealth and diversity of its seaweeds, but as the domicile of the Hopkins Marine Station from which, since its establishment in 1892, many important contributions to our knowledge of the marine life of the Pacific have issued. Among these must be ranked the work which forms the subject of the present review. All botanists who have had or may have the good fortune to visit this privileged region will owe a debt of gratitude to the author for giving them the benefit of his prolonged experience of its seaweed population. Smith's valuable book, which deals with the green, brown and red Algæ of the Monterey Peninsula, is, however, far more than a local flora, since approximately three-quarters of the seaweeds recorded from the Pacific coast of North America occur on the shores of the Peninsula. Moreover, it constitutes the first recent taxonomic account of the American Pacific Rhodophyceæ, since the section dealing with this class in Setchell and Gardner's "Marine Algæ of the Pacific" was never published.

The brief introduction contains a useful section on the distribution of the seaweeds on the shores of the Peninsula, which might with advantage have been fuller. The numerous keys for the determination of families, genera and species are supplemented at the end of the book by comprehensive keys based almost entirely on external form and vegetative structure and designed to facilitate the ready recognition of the genera. The classification follows familiar lines; the Chlorophyceæ are grouped according to the scheme adopted by the author in his other books, while the Phæophyceæ and Rhodophyceæ are arranged on the general lines proposed by Kylin. As I have pointed out elsewhere, I am doubtful as to the value of the grouping of Phæophyceæ under Isogeneratæ and Heterogeneratæ, since in my opinion it obscures relationships. Smith is logical in including among the Ectocarpales (*sens. limit.*), in the Isogeneratæ, the genus *Heterochordaria*, which probably has an isomorphic life-cycle, but its inclusion here removes it from similarly organized forms comprised in the Chordariales, with which it is justifiable to assume some degree of relationship. The author also adopts a new basis of delimitation between the genera *Acrochætium* and *Rhodochorton*, referring to the latter all those species of *Acrochætium* in which tetrasporangia are known to occur. This will scarcely find favour with most algal workers; it might be more appropriate to adopt Drew's suggestion of grouping all the species in one single genus *Rhodochorton*.

The designations macrospores and microspores, applied to the eggs and sperms of Fucales, rest on so speculative a basis that they appear out of place in a work of this kind. In general, however, the diagnoses, incorporating a considerable number of new observations of the author's, are distinguished by their clarity and their ample character. This feature, combined with the copious and excellent illustrations (many of them the work of Mrs. C. F. Janisch) and the general finish of the book, contribute to make this one of the most noteworthy taxonomic works on Algæ published during the present century.

F. E. FRITSCH.

FUNDAMENTALS OF RADIO PHYSICS

Physics and Radio
By M. Nelkon. Pp. viii+388. (London: Edward Arnold and Co., 1944.) 8s. 6d. net.

THE extensive application of radio technique during the past few years has given rise to a need for books on the general basic principles of radio physics. The book under notice goes part way to fulfil this need, and as the author states in the preface, the book should be useful to radio mechanics, wireless operators and students of School Certificate standard requiring a knowledge of the elements of radio.

The first fifteen chapters deal with the fundamental physical principles of electricity and magnetism. Six chapters are then devoted to considerations of the basic properties of valves and their use in various circuits for rectification, amplification and oscillation; these various functions should readily be understood in principle from the treatment given. In a chapter devoted to aerials, the subject is made clearer by several useful analogies with acoustical phenomena. Next follows an account of the fundamental ideas underlying the superposition of intelligence on the carrier wave at the transmitter and its subsequent separation from the carrier at the receiver. Chapter 24 gives first an outline of several phenomena observed in the study of light including reflexion and refraction from the point of view of wave theory; polarization and the differences between longitudinal and transverse waves are also discussed. This outline is intended to serve as an introduction to the behaviour of radio waves in the ionosphere, and suffers somewhat from its brevity; but the treatment given serves to explain skip distance and fading effects. The last of the twenty-five chapters describes a commercial cathode ray oscillograph, and the development of time bases for use therewith. Each chapter ends with a concise summary of the salient points and with a good selection of exercises to be worked out by the reader.

The book is very well written, is liberally illustrated and is eminently suited to the class of reader for which the author intended it. It may even have a wider appeal, for it involves only the most rudimentary knowledge of mathematics, and the calculus is avoided entirely. A very good feature is the inclusion of numerous practical examples which are worked out in the text, so that the student may realize the numerical significance of the various formulæ and properties of circuits.

SCIENCE IN SOCIAL AND INTERNATIONAL PLANNING, WITH SPECIAL REFERENCE TO INDIA*

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THE League of Nations was formed after the War of 1914–18 to promote goodwill and peace among nations, and it is one of the greatest calamities of history that it could not achieve its objective; but it undertook many important surveys on international affairs, knowledge of which is useful for coming to the heart of the international problem. One is the Year-Book, published by the Labour Organisation of the League, which shows in tabulated form the production of commodities in the different political units of the world. This is indispensable for arriving at a proper estimate of the comparative economic condition of different units. The other was the report of the committee for framing an international calendar for the whole world, which, if it could have been adopted, would have gone a great way to promote goodwill and understanding among the principal nations of the world

The Year-Book must have been very largely used by economists I myself, while a member of the National Planning Committee of the Indian National Congress†, tried to form, from the contents of the Year-Book, some idea of the average *per capita* income of the different countries of the world. This proved to be an almost hopeless task; but it was thought that an estimate of the same quantity might be obtained from an entirely different angle, namely, the total energy-production in a country, for we can take wealth to be directly proportional to the output of energy. This is a comparatively easier task, for the energy output is mainly due to the following agencies: (1) Work done by man and domesticated animals. (2) Work done by inanimate agencies: mainly engines using coal, petrol, and other kinds of fuel (bagasse or wood). (3) Work done by electricity derived either from thermal (coal or petrol), or from hydro-electric, sources. Other sources of energy output are negligible at the present time.

Suppose we can estimate the energy output under the three headings accurately, add them up, and divide the whole by the total population of the country. We get a figure which shows the average *per capita* energy output for a country. For the sake of brevity, we shall denote this figure by the term *energy-index*. Let us now see how to calculate the energy-index for a few representative countries of the world just before the outbreak of the present War.

The League of Nations Year-Book gave total production of electrical energy from thermal and hydro-electric sources against every country, so that it is a perfectly simple matter to calculate the contribution to energy-index from electricity for every country. It was 650 for the United Kingdom, 1,700 for Canada, 1,300 for Sweden, and about 1,500 for the United States. These are the most advanced countries of the world, but we may also take some others; the figure was 180 for Mexico, and for progressive countries like the U.S.S.R., it was rapidly increasing from very small figures to those attained by the advanced countries. In countries like Poland, the figure was stationary. For India and China, no figures were available, but according to a Government of India estimate, the total production of electrical energy in India in 1942 was 3,500 million units, so that it comes to only 9 units a head for India. China was rather worse.

It is more difficult to calculate the energy-production from coal or other fuel; for coal mined or imported into a country has many other uses besides energy production, and the efficiency of energy production varies widely. It is not worth while to give all the technical details, but it was concluded that the contribution to the energy-index from coal and other fuel in the United Kingdom amounted to nearly 1,300, and somewhat more in the United States. In India, it could not have been more than 20, for India produces only 26 million tons of coal against Britain's 200 millions, and the use of Indian coal is extremely wasteful.

We, therefore, find that, before the War, the energy-index in the year from inanimate sources amounted in Britain to about 2,000 and in the United States to about 2,500; in India it could not amount to more than 30, and even that is probably too liberal an estimate

Where does the energy production by man and domesticated animals come in this picture? A man working eight hours a day for three hundred days in the year produces only 180 units, and assuming that one third of the population is engaged in productive work, which is not far from the truth, the average cannot be more than 60 units *per capita* a year. The energy production by animals, by wind and water-power in the Middle Ages would not exceed 20 units, so we are not far from the truth if we say that in the Middle Ages the energy-index in all countries amounted to about 80 units, with small variations from country to country. This is negligible compared with energy production in a modern country, by steam, electricity and petrol, and can be almost entirely left out. Man's function, in the present days of technocracy, is merely directive.

These arguments are simple enough, but we can draw from them some very important conclusions. It is obvious that in advanced countries of the world, man, by harnessing the forces of Nature, has increased the energy-index by twenty to thirty-five times within the last hundred years, and this has caused a profound revolution in society. Let us see what this revolution is.

Most old-fashioned history books tell us only of kings, emperors, nobility, and of the privileged few, and omit entirely the common man; and from their perusal we are apt to form sometimes a romantic, uncritical picture of ancient and medieval times. But critical historical research has shown that even two hundred years ago the standard of living for the ordinary person, and conditions of public health in every country, were appallingly low compared to modern standards. Only a few who possessed slaves could afford to have some 'comfort', but it was not much compared to the standards now enjoyed even by the ordinary citizen in an advanced country of the world. In the sixteenth century, there was terrible mortality among children, and even royal children used to suffer heavy mortality due to

* A lecture delivered before a joint meeting of the British Institute for International Affairs, and the British Association for the Advancement of Science, on November 10, 1944.

† The National Planning Committee was appointed by the president of the Indian National Congress in October 1938, with Pandit Jawahar Lal Nehru as chairman. It appointed twenty-nine sub-committees, held a number of discussions, and framed resolutions for the economic and social regeneration of India Its activities were terminated in 1941 owing to the incarceration of the chairman.

diseases now found to be preventable, thanks to science.

The philosophy of kindliness and service to our fellow-men was preached by all founders of great religions, and no doubt some great kings and ministers of religions in every country and at all ages tried to give effect to this (altruistic) philosophy. But the efforts were not successful, for the simple reason that the methods of production of commodities were too inefficient to yield *plenty for all*, which is an indispensable condition for practical altruism.

We can therefore hold that, *so far as individual life is concerned*, science has achieved the target aimed at by the great founders of religions in advanced countries of the world. The effects of maldistribution of wealth, due to historical causes, are being rapidly cured by the introduction of social laws.

The advanced States of Europe, and also the United States of America, began to move out of those dreadful medieval conditions during the seventies of the last century, when modern science began to develop and new methods of production were applied on a mass scale. As a result of a century of progress, individual conditions of living and public health have steadily improved in Britain and in many other countries of Europe and America. Probably the best index is afforded by the average life, which has increased from twenty-nine about a hundred and fifty years ago to fifty-eight in 1944 in the United Kingdom, and to sixty-three in the United States, according to reliable reports. Not satisfied with that, Britain is having a social insurance measure on the lines of the Beveridge Plan, which will take care of the man from the 'cradle to the grave'.

Indian Conditions

Let us now come to my own country—India. Figures have been given which show that the energy-index in India is not more than 100 units, or at best 120 units. It is twenty to thirty times smaller than in the advanced countries of the world. The National Planning Committee estimated the average income of the Indian in 1938 to be Rs. 65 or £5, which can be compared to the average income of the Britisher about the same time (nearly £120). This figure, when it was published, was challenged, but our method of approach—which is radically different—leads us to an identical conclusion*.

Recently the Royal Society sent a distinguished ambassador of science, Prof. A. V. Hill, to India, and he took pains, as no other man has previously done, to study first-hand the conditions of public health, and to some extent observe the general economic conditions in India. He has stated his findings publicly, and they are practically the same as mine By whatever standards you measure, you find 90 per cent of India is still in the Middle Ages. The thin veneer of modernism which travellers find in the great cities of Bombay, Calcutta and Delhi must not lead you astray. Ninety per cent of India is still in the sixteenth century conditions of England. We have terrible child mortality, the conditions of public health are appalling, and 90 per cent of the people have to live in slums. They have scarcely any interest in life, and we are on the brink of disaster, as Prof. Hill has told the British public repeatedly.

* According to a P.E P. report, the total income of Britain in 1944 was ten thousand million pounds, which makes the *per capita* income a little more than £200. This is due to war inflation, and is compensated by the cost of living. In India, the average income has risen during the War, but the cost of living has increased according to official estimates 2 6 times, and according to non-official estimate, nearly 3·5 times.

The National Planning Committee of the Indian National Congress had rightly concluded that India had been almost entirely untouched by modern scientific methods, and if she wanted to pass out of the present dreadful conditions, she must tackle seriously the great task of applying modern scientific and industrial methods for the development of her potential wealth, as has been done by the U.S.S R. with signal success within the past twenty-five years.

Is there any indication that the problem is being properly understood by the central or provincial Government circles ? The problem is so urgent that nobody can shut his eyes to it, and one would conclude so from the appointment of many post-war planning committees ; but the pronouncements made by these committees from time to time only add to the general confusion. Some advocate road building without trying to find out who are the men who will use the roads, and for what purpose and by what conveyance , some advocate agriculture , others think there is an inherent antagonism between agriculture and industrialization ; but the ordinary man only sees that the terms of superannuated officers are extended on higher salaries. The fact is that the planners lack *direction* from the centre.

It is obvious that the clearest way to define the objective would be to declare that India's *per capita* income should be progressively increased to modern figures compatible with her resources ; and as a necessary first step, India's energy-index should be progressively increased to the figures attained in all modern countries. Let us put a definite target, say 100 units within the next ten years ; and we shall also have to use this energy suitably. This is not a large figure, for even pre-war Mexico used to produce 180 units of energy per head, and we produce now only 9 units. Such a declaration, if it is forthcoming, would convince the people, as nothing else would do, of the Government's seriousness of purpose. The Government would have to set up proper machinery for producing electrical energy within the next ten years, and to find a use for the energy for the benefit of India's masses. Let us look at this figure from another angle. It is slightly larger than the pre-war production of electrical energy in the United Kingdom, and according to a P.E.P. report, nearly £600,000,000 was invested in the electrical industries in Britain. Probably a comparable amount will be needed in India, but if the undertakings are properly planned, many of the mistakes committed in the past can be avoided, and a smaller sum may be sufficient. It will also greatly promote trade relations between India and the United Kingdom, as in the case of the U.S.S.R., for India will have to depend for a long time yet to come on imported machinery for her development.

Industry vs. Agriculture

If a policy of progressive electrification of India be agreed upon and undertaken, we shall have to spend most of the energy produced in industrialization. Many critics have seen in this policy a menace to agriculture and to the agricultural population, and have raised the cry of agriculture versus industry. But this is due to confusion of ideas, and a little thinking shows that there is really no conflict between industry and agriculture. As a matter of fact, the position of agriculture in India has been entirely misunderstood, and misinterpreted.

According to the census figure of 1931, which is the latest available to us, only 15 per cent of the popula-

tion of India is urban and 85 per cent is rural, of which nearly 70 per cent is directly dependent on agriculture. Anybody having the slightest knowledge of economics knows that this is a very unhealthy sign. Probably with the exception of China, no other country in the world has such a large percentage of her population on the land. In some parts of Bengal, the holding is two-thirds of an acre per head of the population. The remark of Julian Huxley, referring to the Tennessee Valley of twenty years ago, may be applied with far greater emphasis: "Primitive in their reproductive habits as in their farming methods, they multiply rapidly until they present a typical Malthusian population, pressing hard upon the land's capacity for subsistence".

How has this state of affairs been brought about? We have reasons for believing that before cheap factory goods began to pour into the markets of India, there was a far better balance between the people actually employed in agriculture, and the artisan classes. When industrial revolution started in England, the rural population of England was sucked into production centres, which rapidly grew into large cities, and the urban population grew rapidly. In India, the effect was in the reverse direction. When cheap factory-made goods began to pour into the markets of India, most of the artisan classes—weavers, spinners, blacksmiths, potters and metal workers—lost their jobs and became peasants. With the introduction of railways and steamships, people engaged in the transport trade lost their jobs and were thrown upon the land. The successive famine commissions have rightly diagnosed the excessive pressure on land to be one of the causes of malnutrition and recurrent famines, and recommended that the burden should be taken off the land by providing a large section of the population engaged in agriculture with industrial occupation. But the small amount of industrialization which had taken place in India is totally inadequate for taking the burden off the land.

But one must not forget that in spite of the disproportionately large number of men engaged in agriculture, there is not sufficient margin of safety as regards production of food for India's four hundred millions. The Bengal famine of 1943 appears to have focused the attention of the world on this point, and though this disaster was precipitated by a variety of causes, in which food shortage played a minor part, one must not forget that there is a chronic deficiency of food, both of vegetable and animal origin, and there is consequently permanent malnutrition. India is just on the verge of a crisis, as Prof. Hill has repeatedly stated, and any small cause may precipitate it. The fact is that, owing to over-population, which is itself a consequence of over-ruralization, man in India is making too much demand on the soil, which is not allowed to rest or recouperate. A survey of the productivity of the soil of India recently carried out by Dr. Burns, agricultural commissioner to the Government of India, shows that it produces on the average four times less crops than soil in advanced countries, and according to some sporadic investigations, the soil of India is deficient in nitrogen, phosphorus and potash, and, due to the causes just mentioned, productivity is diminishing year by year.

But why does not the Indian peasant use fertilizers to increase the productivity of the soil, as has been done in other countries? For some reason best known to themselves, neither the Government, nor the Imperial Council of Agricultural Research, has paid any attention to the fertilizer problem, and no synthetic fertilizer industry has grown up in the country which can deliver to the peasant suitable fertilizers at economic prices. According to Dr Burns, if India is to attain safety in food production, the yield should increase by 30 per cent, and this needs nearly a million tons of nitrogen in the form of ammonium sulphate and other fertilizers. Many parts of India show unmistakable signs of phosphorus deficiency, but nobody has yet surveyed her total needs in this respect.

In short, a native fertilizer industry is indispensable for greater agricultural production, and this alone will consume a large amount of the electrical energy to be produced. But this is not all

The Indian agriculturist, like agriculturists in other parts of the world, cannot depend upon food crops alone. He has to raise also cash crops such as cotton, jute, sugar, oil seeds and tobacco, each one of which is useless unless it is utilized industrially. Fortunately, the corresponding industries have developed in India, though there is far more scope in this direction. India has almost none, or few, food-processing industries, and her excellent and wide variety of fruits are on the market only for a limited season. There is a great future in this line, but no food-processing industry can flourish without the refrigeration industry. Further, as Sir Harold Hartley has told us in his Mather Lecture, agriculture and forestry can serve as a potential source of raw materials in scores of industries—such as the manufacture of rayon, paper, plastics, liquid fuel, industrial gases—and the development of all these industries requires cheap power.

There is therefore no inherent antagonism between industry and agriculture; and without development of agricultural industries, the rural population of India can never be pulled out of the dreadful medieval conditions in which they find themselves, breeding a Malthusian population which has been a matter of extreme concern to the rulers. For urbanization means better living, and better living leads to moderate increase of population.

Natural Resources of India

But has India sufficient resources for a balanced development of industries and agriculture on the lines just indicated? According to a competent authority, India, like the United States of America, the U.S.S.R. and China, is one of the few political units of the world which has enough potential resources in power, minerals, and forest and agricultural products, for a balanced development of industry and agriculture to produce *plenty* for her population. The first problem to be tackled is that of power. India has, according to the work carried out by the Geological Survey of India, 60,000 million tons of coal within the first thousand feet of the surface. This is a comparatively small figure compared to the enormous resources of Great Britain and the United States, and most of these deposits are to be found in a small region in eastern India. But she has plenty of 'white coal'—water-power resources—awaiting development. According to a very imperfect survey—or should I say an intelligent guess—carried out nearly twenty years ago by an officer of the Government of India, her water-power resources amount to nearly 20 million* kilowatts, and so far only half a million

* The water-power resources of pre-war Russia were estimated in Czarist days to be 14 million kilowatts. A detailed survey carried out early in the Five-Year Plan pushed up the figure to 280 million kilowatts.

kilowatts have been developed. But the figure is probably a gross under-estimate as in the case of the U.S.S.R. The first problem before the Government of India should be, therefore, to carry out an adequate survey of the hydro-electric resources of India, and plan for the development of ample power for industries.

Civilized life in India has, from time immemorial, grown in river-valleys, which have been used for navigation and irrigation. During the British regime, development has been one-sided, namely, for irrigation only, and navigation has been allowed to fall into decay. But both Soviet Russia and the United States of America have, within the last twenty-five years, set a new ideal for river development. We can take, as a typical illustration, the development of the Tennessee River, which before 1933 was a matter of great concern to the Federal Government on account of the destructive floods, soil erosion, and progressive pauperization of dwellers of the valley. But it is now well known, thanks to the initiative of American statesmen, that this river has been completely transformed by the construction of twenty-one dams over the main river and tributaries. These dams serve the multiple purpose of flood-prevention, navigation and power development, and soil erosion has been prevented by auxiliary measures. The hitherto untamed river, instead of being allowed to dissipate its energy on destructive work, is now harnessed and yields 12,000 million units of electrical energy, which is used for great productive works which have sprung up in the valley (metallurgical, chemical and fertilizer industries).

The multi-purpose development of a river valley, the benefits of which have been so strikingly demonstrated by the Tennessee Valley Authority, is applicable to at least a score of river valleys in India. I have made a particular study of the Damodar Valley, an area of 9,000 square miles, which forms the country to the west of the great city of Calcutta. The lower part of this valley, forming the suburban area of Calcutta, was, a hundred years ago, one of the healthiest regions of the world. But after the construction of railways from 1850, and great roads to connect Calcutta with upper India, embankments were reinforced and constructed on the left bank of the river in order to protect these highways from the destructive river floods. These embankments have by no means removed the danger to the highways; for in 1943 there was only a moderate flood which breached the line at numerous points, and seriously interfered with traffic to Calcutta at a very critical period of the history of the country. They have, in addition, turned the country into a malarial swamp. Even the safety of Calcutta is endangered.

I have shown by a preliminary study that this valley can be subjected to the same treatment as the Tennessee, and can be developed for energy generation (to the extent of 2,000 million kW. a year), navigation, and flood prevention. The lower valley can be transformed by auxiliary methods of irrigation into a fine suburban area, where the teeming population of Calcutta can expand.

But the Damodar Valley is not unique. The Sone, the rivers of the Deccan (the Kaveri has been developed to some extent), the Mahanadi, the Punjab rivers, and many others too numerous to mention, can be developed according to the T.V.A. methods for the benefit of India's millions.

This is only a cursory survey of the problems of India and of the way in which we have to look at it. It is regrettable that the Indian leaders have so far paid attention only to the question of political freedom. It is natural that everyone of us should want our country to attain full nationhood and the people have full sovereignty, but the problem of living for millions of Indians cannot be postponed; in fact, we believe that the only way to achieve unity of thought and purpose in the political field, which is now wanting, is first to look at the problem of living for India's millions. To solve this problem successfully there must be a national purpose behind all planning, and I do not see how any planning can be given effect without a National Government, or unless we have a Government which has popular support and is composed of leaders in whom the people have confidence.

ASTRONOMICAL AND GEOPHYSICAL PERIODICITIES

A GEOPHYSICAL Discussion on "Astronomical and Geophysical Periodicities" was held in the rooms of the Royal Astronomical Society on December 8, 1944; the chair was taken by Prof. L. M. Milne-Thomson, and in the absence of Dr. Harold Jeffreys through indisposition, the discussion was opened by Dr. H. R. Hulme.

Dr. Hulme's interest in this problem originally arose in connexion with the reality of the supposed periodical variations in the solar constant. Any time-series of observations can be analysed by the routine method of harmonic analysis, and amplitudes will be obtained which will not in general be zero, even when there is not the slightest reason for suspecting the presence of a periodic variation; such an analysis has, in fact, often been carried out with geophysical data. The first attempt to find a criterion for the reality of a periodic term was made in 1906 by Sir Arthur Schuster, who found that if n independent observations were analysed into their Fourier components the average amplitude ρ of a Fourier coefficient is $2\sigma/n^{1/2}$, where σ is the standard deviation of the n observations; if, then, the observed amplitude is ρ_0, the chance that such a component could arise purely as a result of random fluctuations is e^{-k}, where $k = \rho_0{}^2/\rho^2$ Thus, if the amplitude found is more than twice ρ, there is some ground for suspecting that the periodicity may be real.

The Schuster criterion, however, takes no account of internal correlations among the data. Thus a naive view of the problem may give misleading results; if, for example, the observations are subject to disturbances, each of which affects a number of consecutive observations, the effective number of independent observations may be far less than n. Moreover, the criterion is of limited usefulness, since an investigator who thought that the values of a series of observations were all independent of one another would not be likely to make a harmonic analysis of the results. A more searching method of analysing a time-series was given in 1927 by Mr. G. Udny Yule. He considered two types of periodicities: the periodic phenomena where each disturbance affects only the momentary value of the quantity observed; and periodic phenomena in which each disturbance affects all the subsequent values, as, for example, a change of phase. The latter type would be discussed by Mr. M. G. Kendall. Dr. Hulme pointed out that an outstanding problem is to find

how to test whether a given oscillation belongs to one or other of these types.

Mr. H. W. Newton stated that more than two hundred years elapsed between the discovery of sunspots and the discovery of their eleven-year periodicity; the success of Schwabe in discovering the eleven-year cycle in 1610 might be attributed to his systematic work and to the fact that he continued his observations over three or four solar cycles. A graph of the frequency of naked-eye sunspots indicates that an observer with a piece of smoked glass making systematic observations like Schwabe could have discovered the eleven-year cycle; it is possible, however, that observers in the seventeenth century may have been frustrated by a 'submergence' of the sunspot cycle. The observed reversal of the polarity of the magnetic field in sunspots suggests that the fundamental period is twenty-two years; this, however, is not obvious from the diagram of many sunspot cycles as measured at Greenwich, though Turner got a difference from spot area data, 1842–1910, nor does it show up in Maunder's famous diagram (the 'butterfly' diagram) of the cyclical change of latitude of sunspots.

The Zurich 'sunspot numbers' from 1750 until 1911 were subjected to a harmonic analysis by Kimura As in the customary method of predicting tidal heights, Kimura computed the form of the extrapolated curve after 1911, this prediction was not realized, for the time and amplitude of the next following maximum observed in 1917 were in marked disagreement with Kimura's values. Other analyses had been made by Newcomb, Schuster, Yule, Waldmeier and others, the average length of the cycle may be accepted as 11–13 years. Mr. Newton emphasized the necessity of using a long series of data in any attempt to establish a periodicity or a correlation; for example, the annual excess of turns of a weather vane at Greenwich, direct over retrograde, had been compared with the sunspot cycle, and it was found, rather surprisingly, that a general parallelism existed for some years. This correspondence, however, did not persist, and the parallelism appeared to be quite fortuitous. In conclusion, Mr. Newton showed a diagram of the comparison over thirty years of the monthly sunspot areas and the diurnal inequality ranges in magnitude of the terrestrial magnetic elements D, H and V. The correspondence is very striking, and extends to the details of the curves; later observations confirm the closeness of the correlation, and give values as high as 0·95 for the coefficient of correlation for individual eleven-year cycles.

Mr. M. G. Kendall, in his contribution, explained that although he knew little about astronomy, he believes that many of the oscillatory movements in time-series which are found in geophysical and meteorological data possess similar features to those in economic series in which he is primarily interested. In this connexion he wished to direct attention to the large amount of work which is being done on time-series in quite unrelated fields, the necessity for an interchange of information between workers in different branches of science, and some co-ordination of effort.

The classical method of analysing oscillatory movements is to exhibit the series as a sum of harmonic terms If, as usually happens, observation differs from mathematical representation, the differences, however large, are regarded as errors of observation in the sense that their effect is instantaneous and does not endure in the future motion of the system. For most practical series, this does not appear to be a plausible hypothesis, because disturbances of the motion, though possibly random in the sense that their occurrence is according to the laws of chance, permanently affect the future motion of the system and are incorporated into it.

The statistical problem is to find a mathematical representation of such a system. The nearest approach to a solution so far advanced was that given in 1927 by Mr. Udny Yule in his paper on sunspots. Yule was led to consider a type of series, which has been called 'auto-regressive', in which the value at any point is partly a function of those at previous points, and partly a disturbance function. One simple form of this type of series can be written

$$u_{t+2} + au_{t+1} + bu_t - \varepsilon_{t+2} = 0,$$

where ε_{t+2} is the disturbance, which can in particular cases be random. Mr. Kendall has recently constructed a number of artificial series of this type and analysed them by the Schuster periodogram method. The results are very striking. Not only does the periodogram fail to reveal the true nature of the series, but also it suggests quite a large number of periods where none exist. He has come to the conclusion that for series of this type periodogram analysis is not worth the labour of undertaking.

Mr. Kendall has also considered the practice of counting peaks in a series as providing an estimate of 'period'. For autoregressive series of the type mentioned, it appears that this is an extremely insensitive method inasmuch as for the majority of values likely to be encountered in practice it will give a value somewhere between 4 or 6 units, whatever the nature of the series. His experimental series and a number of practical economic series do in fact give such values, and the appearance of 'periods' of this kind throws very little light on the true nature of the generating process.

Reference was also made by Mr. Kendall to the technique introduced by Mr. Yule of computing the serial correlations of the series. This appeared to give much more reliable results, but is not without its difficulties. In conclusion, he said that in his view a great deal of the work which has been done on the analysis of oscillatory movements will have to be reconsidered; he is convinced that 90 per cent of the 'periods' which have been claimed by different writers were spurious.

Miss N. Carruthers discussed periodicities in weather phenomena. She said that there are some true periodicities, such as, for example, the annual and diurnal variation of most meteorological elements, but it is doubtful whether they are truly represented by combinations of sine curves. In addition to these, spasmodic oscillations are found in most series of meteorological data. Some may be purely random fluctuations, but others have a tendency to reappear at intervals with the same wave-length, although not, in general, with the same phase. The latter most often persist for three or four wave-lengths only, after which they either end abruptly or change phase unexpectedly. Examining meteorological waves (the irregular kind can scarcely be termed periodicities) with Dr. C. E. P. Brooks, it had been found that determination by harmonic analysis is unreliable, and a year ago they devised the 'periodoscope' which Miss Carruthers described before the Royal Meteorological Society last June. In this form of analysis, by a simple combination of the terms in a series

containing periodicities, a new series is formed in which these were retained with period and phase unaltered. For periods lying within a pre-assigned range, however, amplitudes are magnified, so that, when the new series is plotted, the corresponding periodicities can be readily identified by eye with the aid of key curves drawn on tracing linen. Examples of waves found by this means in London temperature were contrasted with the more regular sunspot cycle (9–13 years) treated in the same way.

Most waves in meteorological phenomena appear to be natural oscillations of the earth's atmosphere. Haurwitz, Lettau and Defant deduced theoretical periods of 6–57 days, all of which have been found in pressure and some also in rainfall. These, however, are not set up without some external stimulus, just as a violin string does not emit its characteristic note of its own accord. The fragmentary nature of these waves can, likewise, be explained by analogy with a violin string; for if the string receives impulses at intervals incommensurate with its period of vibration, the vibrations break up and change phase abruptly with each fresh impulse. The analogous impulses received by the atmosphere appear to be connected with variations of solar radiation. That these occur at intervals which are not natural periods of atmospheric vibration is indicated by a comparison of prevailing periods in the solar constant and in European pressure:

Solar Constant	75, 51, 37, 25, 19 days
Pressure . ..	72, 48, 36, 24, 18 days

A further illustration is afforded by the 3-year wave in the pressure at Darwin, which has been found by C. Braak to break up and change phase about the time of sunspot maximum; this is probably the same as the waves found earlier in India and the Argentine by Sir Norman Lockyer and identified as 3½-year periodicities.

Other periods indirectly induced by solar radiation are connected with interchange of air between continents and oceans and outbreaks of cold air from the polar regions. The moon induces a semidiurnal atmospheric tide which is a true periodicity, but it is too small to have any appreciable effect on the weather.

Mr. P. M. Ryves summarized the general characteristics of stars the intrinsic luminosity of which is variable; these constitute only a small percentage of the stars observed, but they cover the whole range of spectral classes from *O* to *M* and *N*. Periods range from 1½ hours to 20 years or more, but periodicities of more than two years generally correspond to small amplitude of variation, and are often irregular or uncertain, and frequently complicated with superimposed shorter periods. There is a very definite correlation between length of period and spectral class, the shorter periods corresponding to the hotter early-type stars and long periods to late types. Though variables can be found with periods anywhere between the limits mentioned, a frequency curve shows three prominent peaks, one corresponding to the RR Lyrids with mean period of about half a day, the second to the Cepheids (really a double peak with a minimum at about nine days), and the third, at a little short of 300 days, to the Mira-type and other long-period variables.

Dealing particularly with the long-period variables, Mr. Ryves mentioned that typical Mira-type stars have a mean amplitude of about five magnitudes, with spectral class *M*3 to *M*8 (90 per cent), or *N* (5 per cent) or *S* (5 per cent), all with emission spectrum, and periods for the most part between 150 and 550 days. The magnitude at maximum varies in individual cycles to the extent of one magnitude or more, and the magnitude at minimum also varies, but generally to a smaller extent. The period is frequently irregular in the sense that any given phase may be unpunctual to the extent of 5–10 per cent, but the mean period is fairly constant. Apart from these oscillations about the mean, there are sometimes permanent changes: (*a*) a sudden change in the length of the period (this has happened more than once in some stars), (*b*) a discontinuity, or shift in the phase, without change of period. Mira-type stars show a small progression of spectral class with increasing length of period, and also, but with many exceptions, a progression from symmetrical to asymmetrical light curves, and increase in amplitude. The shape of the curve may vary a good deal from cycle to cycle, and there is sometimes a pause or hump as in the sunspot curve; this happens more frequently on the ascending than on the descending branch. In some cases the hump is a more or less permanent feature, and shows up on the mean curve. The variables have large space-motions, and are probably revolving about the centre of the galaxy in highly elliptical orbits.

Parallel with the Mira-type variables is another group of stars comprising the red semi-regular variables and the so-called red irregular variables. The fundamental difference is that these have no emission spectrum, or at most a very faint one, and that the amplitude is much smaller, usually one or two magnitudes. The variation is also less regular, both as regards punctuality and the shape of the light-curve. Double maxima, or a tendency for deep and shallow minima to alternate, are common, and a long-term variation in the median magnitude sometimes appears. With irregular variables there may be several maxima at fairly regular intervals, followed by a period of disturbance, after which a new series of maxima appears, quite out of phase with the former series.

Dr. R. Stoneley recalled a paper by Dr. H. Jeffreys that is extremely relevant to the present discussion. Many harmonic analyses had been made of the occurrence of earthquake shocks, notably by Prof. H. H. Turner and Dr. C. Davison. The latter had applied the Schuster criterion to his results, and *prima facie* had found good evidence for the genuineness of a number of the periodicities. Dr. Jeffreys found that the existence of internal correlations among the data would increase the random amplitudes expected in a Fourier analysis, and would therefore vitiate the direct application of the Schuster criterion. The phenomenon of aftershocks following a large earthquake does imply that all the shocks recorded in a catalogue cannot be treated as random occurrences. In the aftershocks of the Tango earthquake of March 7, 1927, the falling-off of the frequencies of the aftershocks is consistent with a regular law of chance that depends only on the time-intervals elapsing since the main shock and a second strong shock on April 1, 1927, but otherwise the aftershocks appear to be mutually independent. The amplitudes obtained for periodicities superposed on this variation are not such as would give any support for the realities of these periodicities.

As was stated at the beginning of this article, Dr. Jeffreys was not present at the meeting, but was asked to comment on the above report. He emphas-

izes that the Schuster criterion is the particular case of Pearson's χ^2 test when the number of degrees of freedom is 2. The analysis of the variation of latitude observations shows the same kind of serial correlation as Yule has considered, with the additional complication that the disturbances do not appear to be derived from the normal law. Fortunately, it was possible to find a long interval when there seems to have been little disturbance. In this problem there is an observational error special to each datum and also a real fluctuation the successive values of which are correlated, the method of maximum likelihood can deal easily with either by itself but becomes prohibitively complicated when the two are superposed.

HÆMOGLOBIN IN THE ROOT NODULES OF LEGUMINOUS PLANTS

By PROF. D. KEILIN, F.R.S.

AND

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THE red pigment in the root nodules of a leguminous plant (*Vicia Faba*) was investigated for the first time by Pietz[1]. He believed it to be identical with the red intermediate product which appears during the oxidation of tyrosine or of dihydroxyphenylalanine ('dopa') catalysed by tyrosinase. According to Pietz, the red pigment, by undergoing a reversible reduction, has the function of poising the oxido-reduction potential of the nodule at a level favourable for the proliferation of symbiotic bacteria inhabiting the nodule.

Pietz' conclusion, however, was based not upon the direct study of the pigment, but upon certain considerations derived from the study of oxido-reduction potentials of nutrient media in relation to growth of symbiotic micro-organisms, and the fact that the addition of 'dopa' to the medium favours the growth of these bacteria.

A year later the pigment in the root nodules of a great variety of leguminous plants was reinvestigated by Kubo[2] both *in situ* and in preparations obtained by fractionation of an extract of nodules with ammonium sulphate. He examined the pigment spectroscopically and determined the position of its absorption bands under different conditions. Thus when aerated, the pigment shows two absorption bands, at 575 mμ and 540 mμ, which, on reduction with sodium hyposulphite, are replaced by one band at 555 mμ. In the presence of carbon monoxide the bands are shifted to 570 mμ and 535 mμ, and on treating the pigment with potassium ferricyanide a compound is obtained with three absorption bands, at 625 mμ, 563 mμ and 530 mμ. This latter compound was found by Kubo to react with cyanide, fluoride and peroxide. Finally he obtained from this pigment crystals of hæmin indistinguishable from protohæmin. As the result of these observations, Kubo concluded that the red pigment of the nodules is a hæmoprotein compound analogous to hæmoglobin and acting as a store as well as a carrier of oxygen.

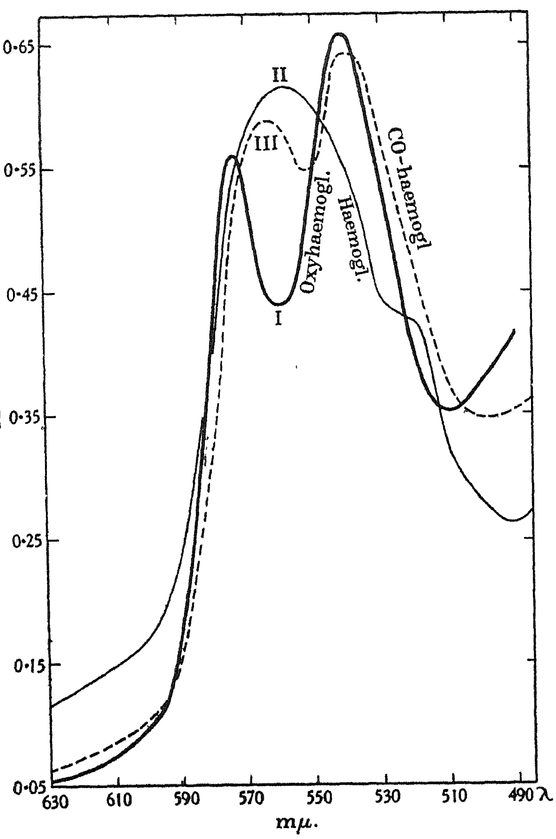
More recently, the nature of this pigment was reinvestigated by Burris and Haas[3] on the material obtained from root nodules of cow-peas (*Vigna sinensis*) fractionated with ammonium sulphate. The light absorption of the pigment thus obtained showed a strong γ-band at 405 mμ characteristic of hæmatin compounds and in the visible region one band only at 530 mμ instead of the two bands described by Kubo. They also found that after "deoxygenation of the solution the spectrum of the oxidized form remains unchanged, indicating true oxidation and not merely oxygenation of the red pigment" On reduction with sodium hyposulphite the γ-band moved to 430 mμ and the band in the visible region was replaced by one at 560 mμ. Burris and Haas agree with Kubo that the pigment is a hæmin compound, but, contrary to his views, they think that its "behaviour towards oxygen indicates that it is not a hæmoglobin-like substance".

The results of the work summarized above leave no doubt that the red pigment in the root nodules of leguminous plants is a hæmatin compound and not a quinone as was postulated by Pietz The object of the present investigation was to determine whether the pigment is an oxygen carrier of the hæmoglobin type which combines reversibly with molecular oxygen, or whether it is an oxidation catalyst which, like the components of cytochrome, undergoes a reversible oxido-reduction accompanied by valency changes of the hæmatin iron.

Although we have examined the nodules of a number of leguminous plants, the material we have used for this study was mainly the root nodules of the soya bean. The pigment was studied either directly in nodules compressed between two slides or as extracts of nodules purified by fractional precipitation with ammonium sulphate.

The position of the absorption bands of this pigment and of its derivatives was determined with the microspectroscope, and the absorption spectra were determined with the Hilger-Nutting spectrophotometer. This was done only for the visible region of the spectrum, since hæmatin derivatives are more readily differentiated by the absorption bands in this region than by their γ-bands.

One of the main difficulties in the extraction of this pigment from nodules, which have to be crushed for this purpose, is the more or less rapid darkening of the pulp and of the extract due to oxidation of a phenolic substance catalysed by the phenol oxidase. The quinone formed during this reaction oxidizes the iron of the pigment and partly denatures its protein, whereas the melanine which is ultimately formed adsorbs the pigment and masks its colour and its absorption spectrum. However, one can overcome these difficulties in several ways. Thus, by crushing the nodules in saturated ammonium sulphate and washing the pulp in the same solution, the phenoloxidase can be precipitated before it has time to act upon the substrate, which can be afterwards removed. At the same time we have added an excess of sodium azide which poisons phenolase and a small amount of sodium hyposulphite which also prevents the oxidation of the substrate and keeps the iron of the pigment in the reduced state. The reduced state can be more efficiently stabilized by saturating the solution during different manipulations with carbon monoxide. Under these conditions the extracts can easily be fractionated with ammonium sulphate, and the fraction between 65 per cent and 84 per cent saturation, which contains most of the red pigment, is collected.



ABSORPTION CURVES OF HÆMOGLOBIN FROM ROOT NODULES OF SOYA BEAN.

I, Oxyhæmoglobin (prep. *A*); II, deoxygenated hæmoglobin (prep. *B*); III, carbon monoxide-hæmoglobin (prep. *B*); extinction coefficient $k = \frac{1}{l} \log_{10} \frac{I_0}{I}$, Preparation *A* contains probably small concentration of methæmoglobin. Concentration of hæmin per 100 ml. in preparation *A* = 4·05 mgm.; in preparation *B* = 3 46 mgm. Preparations *A* and *B* are of different degrees of purity and probably contain a small amount of hæmatin not belonging to hæmoglobin.

The hæmin content of this preparation, estimated spectroscopically as pyridine hæmochromogen, was found to be approximately 2 per cent of its dry weight. If we assume that the total hæmatin found belongs to the undenatured red pigment and that its hæmatin content is approximately the same as that of hæmoglobin, the purity of our preparation would be 40–50 per cent. Preparations of this purity were found to be quite suitable for the study of the main properties of the pigment.

Properties and Nature of the Pigment. A solution of this pigment is deep red and its absorption spectrum shows two distinct bands with the maxima at about α–574 mμ and β–540 mμ; the α-band being narrower and lower than the β-band (Curve I).

On treating the solution with sodium hyposulphite, the two bands disappear and are replaced by one band with the maximum at 557 mμ (Curve II). What is more remarkable, however, is that this change can be obtained in the absence of a reducing agent by warming the solution in a Thunberg tube to about 37° C. and evacuating the tube with an ordinary water pump. After boiling for a few minutes the two bands gradually fade away, being replaced by a single band at 557 mμ. On opening the tube and shaking the solution with air, the two-banded absorption spectrum rapidly reappears.

All this clearly shows that the two-banded spectrum belongs to the oxygenated and not the oxidized state of the pigment. Like hæmoglobin, the pigment of root nodules forms with molecular oxygen a loose and perfectly reversible compound. That the iron of this compound, like that of oxyhæmoglobin, is in a divalent state is shown by its reaction with carbon monoxide, and with potassium ferricyanide. On treating the oxygenated compound with carbon monoxide, its two absorption bands are replaced by two more diffuse bands lying at 564 mμ and 538 mμ (Curve III). The addition of potassium ferricyanide to the oxygenated compound changes its colour from red to brown, and its two absorption bands are replaced by the absorption spectrum characteristic of methæmoglobin.

The failure of Burris and Haas[3] to recognize the true nature of this pigment was probably due to the fact that their preparation contained mainly the methæmoglobin derivative with its band at 530 mμ as described by Kubo. Had they dialysed against water a sample of their preparation treated with sodium hyposulphite, they would probably have noticed the appearance of the oxygenated compound with its two characteristic absorption bands.

The affinity of this hæmoglobin for oxygen expressed as oxygen tension in mm. mercury which corresponds to 50 per cent dissociation of the oxygenated compound was determined spectroscopically at 15° C. and was found to be less than 0·1 mm. The relative affinity of this pigment for oxygen and for carbon monoxide, expressed as the equilibrium constant $k = \frac{(\mathrm{HbCO})\,(p\mathrm{O}_2)}{(\mathrm{HbO}_2)\,(p\mathrm{CO})}$ was determined spectrophotometrically at 15° C. and its value was found to be about 37. It is somewhat higher than the value obtained for myoglobin, but considerably lower than the values found for mammalian blood hæmoglobin. These values should be considered as approximate only, since they have been obtained on samples which were only about 50 per cent pure. They may require a certain correction when the pigment is obtained in a purer form.

That the hæmoglobin is in some way connected with the nitrogen fixation by nodules seems to be supported by two facts: (1) its constant presence in nodules of every leguminous plant so far examined; and (2) the inhibition of nitrogen fixation by a very low partial pressure of carbon monoxide[4]. At such pressures carbon monoxide is known to react mainly with hæmoglobin. However, it is difficult to ascribe to this hæmoglobin any definite function, since the mechanism of nitrogen fixation by nodules is far from being elucidated[5]; moreover, the function of hæmoglobin even in certain invertebrates is not yet properly understood.

General Considerations. The presence of hæmoglobin in root nodules of leguminous plants is of great general interest. It is well known that in animals, outside vetebrates, hæmoglobin has a very irregular distribution, being either completely absent in all representatives of large phyla of invertebrates, or present in only a very few species of a phylum while absent in all other, often nearly allied, forms. Since, however, all cells of aerobic organisms, including bacteria and plants, are capable of synthesizing hæmatin catalysts such as the components of cytochrome, obviously every cell can be considered as a potential carrier of the prosthetic group of hæmoglobin. The limiting factor in the distribution of hæmoglobin in Nature is the ability of cells to

synthesize the highly specific proteins which, when combined with hæm, impart to it the remarkable property of reversible oxygenation. This property, which hæmoglobin shares with only a few natural oxygen carriers, has no analogy among chemical compounds.

The root nodule hæmoglobin represents the first case of the occurrence of this pigment in plants, although other hæmatin compounds such as cytochrome peroxidase and catalase are known in plants. What is, however, more interesting is that neither the plant cells alone nor the symbiotic micro-organisms (*Rhizobium*) cultivated separately are capable of synthesizing hæmoglobin. It is only when the root cells are invaded by specific symbiotic micro-organisms and begin to proliferate that hæmoglobin is formed. *Rhizobium* not only induces growth and multiplication of cells, but also supplies these proliferating cells directly or indirectly with a factor necessary for synthesis of hæmoglobin.

For the plant material used in the present investigation we wish to thank Dr. H. Hunter, Mr. E. G Thompson, Prof. E. J. Salisbury and Dr. Kenneth M. Smith. This work was assisted by a personal grant from the Medical Research Council to one of us (Y. L. W.).

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RUSSIAN RUBBER PLANTS

In recent years there has been a great deal of interest in the study of rubber-bearing plants that will grow in temperate and sub-temperate climates in connexion with the possibility of establishing sources of supply of natural rubber independent of the tropics. Russian workers have been the pioneers in this field, and it is in the U.S.S.R. that the most noteworthy developments have taken place. The published accounts of this work (mainly in Russian) are unfortunately difficult of access, especially at the present time. It is fitting, therefore, that a comprehensive summary (in English) should now have appeared, with special emphasis on what is so far known of the genetics of the plants concerned and what breeding work has so far been carried out with them*.

A brief history is given of the search for rubber-bearing plants in the U.S.S.R. which first began during the War of 1914–18 and of the expeditions that have been arranged for the purpose. Since that time, several thousand species have been examined, and special methods evolved for detecting the presence of rubber both qualitatively and quantitatively. Apart from latex-bearing plants, many species were found to contain rubber in the mesophyll tissue of the leaves, but successful extraction presented many difficulties. The most promising rubber-bearing plants outside the tropics were found to be those containing coagulated rubber in the roots and underground stems. In these plants the rubber, often visible as strands, was found to be more easily separated from the surrounding tissue than was the case where the rubber occurred in the leaves. Furthermore, it was found to have a markedly lower resin content.

The first plant of this class to show promise as a possible commercial source of rubber, if cultivated, was tau-saghyz (*Scorzonera tau-saghyz*), discovered in 1929 on the Kara-Tau mountains of Central Asia. Several forms or ecotypes of the plant are now known to exist. A good account of the plant is given, its growth characteristics and its behaviour under cultivation. Although possessing a good rubber content in the root, the plant proved susceptible to disease and difficult to cultivate satisfactorily in most areas. For this reason it gave way to other rubber-bearing species brought to light a few years later, which proved to be better subjects under cultivation, such as krim-saghyz (*Taraxacum megalorrhyzon*) and kok-saghyz (*Taraxacum kok-saghyz*).

Both these plants are very similar to the ordinary dandelion in general appearance and possess large, rather fleshy roots in which the rubber is chiefly located. Kok-saghyz is the more hardy plant and may be cultivated over a much wider area of the U.S S.R. than krim-saghyz. The latter occurs wild in the Crimea region and is liable to be killed in winter except in places where winter conditions are relatively mild. It is for this reason that interest is now centred mainly on kok-saghyz, and the area devoted to it is the largest of all the areas in which rubber-bearing plants are now grown. The plant is usually cultivated in districts where the annual rainfall is not less than 450–500 mm. and thrives particularly in the central part of the U.S.S.R., as in the Orel and Ivanov territories and in the Ukraine and White Russia, also in irrigated lands in Central Asia. It has been grown as far north as the Kotlas region of the Archangel territory. The plant thrives and gives the best yields on low-lying alluvial land, especially good peaty and humus soils and in particular those that have been well manured. In White Russia, experiments have shown that on peaty soils larger yields of roots with higher rubber content have been obtained than has been found possible on mineral soils. For high yields of root, deep, fertile, friable soils rich in nutrients and with adequate moisture are necessary. Structureless soils, which rain turns into mud and which lack nutrients, or sandy soils, are regarded as unsuitable for kok-saghyz.

A good account is given of the methods adopted in the field cultivation of kok-saghyz from the sowing of the seed to the harvesting of the roots. As germination of the seeds is naturally poor or uneven, pre-treatment or vernalization is often necessary. The seedlings are also somewhat delicate and slow-growing. They are easily choked or smothered by weeds in the early stages. For these reasons the crop is a more difficult one to raise than many field crops. Special machinery has had to be devised for dealing with the crop, particularly in sowing the seed, harvesting the roots and in the collection of seed, which is similar to that of the dandelion and dispersed by wind almost as soon as it is ripe.

Propagation by means of root fragments, which is possible with the plant if certain precautions are taken (as recommended by Lysenko), should offer interesting possibilities, but so far does not appear to have progressed beyond the experimental stage. Pieces of the root 1–2 cm. long cut off in the early spring and allowed to callus in moist sand and planted in place of seed make much more rapid growth than seedlings, and when a few days old

* Cultivation and Breeding of Russian Rubber-Bearing Plants. Imperial Bureaux of Plant Breeding and Genetics, Cambridge, and Horticulture and Plantation Crops, East Malling, England. 2*s*. 6*d*.

resemble seedlings two months old. This simplifies weeding. Another obvious advantage is that high-yielding individual plants may be rapidly propagated vegetatively in this way. A drawback of this method for large-scale or field planting, according to Mynbaevdel, is that the development of the main root is retarded.

Various insects are known to attack the kok-saghyz plant in different stages of its development, and a good account of these is given. With regard to soil pests the chief of these in the more northerly regions is the wireworm. Cockchafer larvæ, which gnaw through the roots at various depths, may also be troublesome.

Genetical work that has been done on certain other rubber-yielding plants in the U.S.S.R. in addition to the above is also reviewed. These include species of *Asclepias*, *Apocynum*, *Solidago* (golden rod), *Scorzonera*, *Chrysothamnus*, *Parthenium* (guayule) and *Taraxacum*. Each genus is treated in a separate section, and information is given under the headings of: *A*, Taxonomy and Distribution; *B*, Cytology and Reproduction; *C*, Variation and Genetics; and *D*, Breeding. Guayule and the species of *Taraxacum* have received most attention, as might be expected in view of the fact that they have shown most promise as rubber producers.

With regard to guayule the opinion is expressed that the breeding stocks in the U.S.S.R. and in the United States differ considerably in their potentialities and that the Russian are inferior to the American. This is not surprising when it is considered that the American breeders have had continuous access to wild material while the Russians have had to develop their strains from a single collection. The fact that the development of American varieties was monopolized by a private firm until recently (1942) has probably discouraged other breeders from investigating guayule. Improvement with guayule has been effected mainly by selection, rather than by hybridization, which is difficult. Strains yielding as much as 22 per cent rubber are now available, and there has been some improvement in plant-size but little in accelerating the growth-rate, plants being normally harvested in their third or fourth year.

Cytologists may be interested in the remarks regarding the genus *Scorzonera*, particularly tau-saghyz, in connexion with which it is stated: "The diploid chromosome number is 14 and each chromosome has a distinctive morphology; they are all two-armed, 2 pairs having median centromeres and 5 pairs sub-terminal centromeres. It has been found that two races of the species exist, each distinguished by its own chromosomal morphology. In one race, satellites are present in three of the chromosome pairs, one of which is heterozygous for a second satellite. In the second race, satellites are completely absent. Examinations of the root tips of *S. tau-saghyz* have revealed rather a complicated picture of chimaeral polyploidy and aneuploidy. Triploid, tetraploid and hexaploid cells have been discovered both in the periblem and the plerome together with aneuploid cells with 15, 16, 18, 19, 20 or 21 chromosomes. It is assumed that these various anomalous chromosome numbers arise by somatic non-disjunction or chromosome elimination. Trisomic cells have been observed in *S. nervosa* ($2n = 12$) but not in other species of the genus. Chromosome numbers of some other species are as follows: *S. hispanica* ($2n=14$), *S. acanthoclada* ($2n = 14$) and *S. tuberosa* ($2n = 12$).

"Meiotic behaviour in *S. tau-saghyz* is aberrant, and the following abnormalities have been observed: lagging chromosomes, adventitious nuclei, chromosome fragmentation, elimination of chromosomes from the spindle, polynucleate pollen and viable pollen with aneuploid chromosome numbers. It has been found however by Poddubnaja-Arnoldi, Steschina and Sosnovetz (1935) that gametogenesis is regular and that subsequent irregularities, which affect both the megaspores and the pollen grains, are due to the low temperature and high humidity of the plant's normal environment."

In the breeding of tau-saghyz the importance of selecting plants for vegetative vigour is stressed, for the mortality-rate of unselected plants may be very high and reach 100 per cent. The fact that tau-saghyz is very susceptible to disease may, it is thought, be correlated with the scanty soil microflora in its native habitat The advantages that might accrue from hybridizing tau-saghyz with the vegetable scorzonera (*Scorzonera hispanica*), which has been so long in cultivation and has vigour and a stout root, are emphasized.

Investigations of the cytology of kok-saghyz have been made by a number of workers. "There are eight pairs of chromosomes one of which has satellites attached. Meiosis is normal both in pollen grains and ovules and nearly 100 per cent pollen fertility is reported. The pollen is viable for five days, and fertilization takes place in 15–20 minutes, according to Poddubnaja-Arnoldi and Dianova and 30 minutes at 70° F. according to Warmke. The embryo-sac usually develops from the chalazal megaspore. A high degree of self-sterility is usual although some 'end season fertility' is reported from America; the cause of this is obscure and the possible effects of temperature, light and the age of the plant have been suggested. Cross-pollination, which seldom occurs naturally if insect visitors are excluded, produces 100% fertilization. The fertilized embryo develops normally although supernumerary eggs and sperms are formed quite frequently. It is possible that functional polyspermy may occur occasionally in the endosperm but only triploid nuclei have been observed up to the present. There is no evidence of apomixis in this species and it is regarded as extremely improbable."

Crosses have been made between kok-saghyz and about half a dozen other species of *Taraxacum*. "The hybrids are very highly sterile; normal meiosis occurs but is followed by subsequent degeneration of the gametes or the embryo. In the latter case, irregular nuclear fusions were observed in the early developmental stages. Koroleva (1939) managed to produce an F_2 and F_3 from the cross *T. kok-saghyz* × *T. multiscaposum* by back crossing with the former species."

It is interesting to note that seed of three of the rubber plants here dealt with (tau-, krim- and kok-saghyz) was obtained from the U.S.S.R. a few years ago and small trials carried out at the Royal Botanic Gardens, Kew, and in various parts of the British Isles. Tau-saghyz appeared to be quite unsuited to the climate; but plants of kok-saghyz and krim-saghyz were raised successfully at several centres and good-quality rubber extracted, but only on a laboratory scale. With all these plants yields are very much inferior to those obtained with *Hevea* or plantation rubber. From the point of view of world economy they may be of comparatively little value, and it is only when self-sufficiency is desired that they become of general economic importance.

NEWS and VIEWS

Chair of Logic and Metaphysics at Edinburgh

Prof. N. Kemp Smith

FOR more than a century, largely on account of the eminence of its occupants, the chair of logic and metaphysics in the University of Edinburgh has been very generally, although quite unofficially, regarded as Scotland's premier philosophical chair. Since 1836 there have been four occupants, Sir William Hamilton (1836–1856), Campbell Fraser (1856–1891), Pringle-Pattison (1891–1919) and Norman Kemp Smith from 1919 to the end of the present academic session, when he retires. All four were celebrated for their mastery of the history of ideas, particularly in the eighteenth century and around it. Sir William Hamilton by work which, nominally at least, took its origin from Thomas Reid, Fraser by his unwearying labours on Berkeley, Pringle-Pattison by his dominant neo-Kantianism, and Kemp Smith by his massive study of Kant and of Hume. It is not very reckless to suggest that the last of the four professors surpassed all the others in this common tradition. Our standards in this field are very much higher in the present century than in the last, and only partially because the last had done so much. The intensive study of Kant which is so marked a feature of contemporary British academic philosophy owes more to Kemp Smith's "Commentary" than to the pen of any other English-writing author. His work on Hume, beginning with two masterly articles in *Mind* (1905), and continued in his edition of Hume's "Dialogues" (1935) has (perhaps) concluded with his "Philosophy of David Hume", a book which outstripped all other contemporary work on Hume, British or foreign, by a very comfortable margin. Kemp Smith brought to his classroom the high qualities that he showed in his writings, and all his varied contacts with students, colleagues and the public gained, in addition, from his broad humanity, his deep interest in the social problems of the present day and his catholic appetite for modern history and biography. He knew the United States well, for he was professor in Princeton between 1906 and his return to Europe to serve in the Ministry of Information during the War of 1914–18, and, in 1923, he was a visiting professor in Berkeley, California. A friend to both sides of the Atlantic, he was, is, and, one hopes, will long continue to be, one of the strongest links in the chain of Anglo-American unity and understanding in academic affairs.

Prof. A. D. Ritchie

IN inviting Prof. A. D. Ritchie, at present professor of philosophy in the University of Manchester, to succeed Prof. Kemp Smith, the electors have shown a courageous readiness to avoid too rigid an adherence even to a tradition so firmly established, for Prof. Ritchie, who has accepted the invitation, is as much a man of science as a philosopher. They may, indeed, be renewing the tradition. Sir William Hamilton, among his many pre-professorial activities, had studied medicine and had qualified for the Bar. Superficially, however, there is something like a break in the tradition. Prof. Ritchie's principal philosophical books are about scientific method and the natural history of mind. His other book deals with the comparative physiology of muscular tissue. His fellowship at Trinity College, Cambridge, was earned for his work in chemistry, and he was a lecturer on chemical physiology in Manchester before succeeding J. L. Stocks in the chair of philosophy there. Some may think that first-hand acquaintance with the inferences of experimental science, accompanied by writing upon its general theory, is the best possible preparation for the teaching of logic As for philosophy in a wider sense, including metaphysics, Prof. Ritchie's varied articles upon many themes, religion and sociology among them, give ample evidence of his interest and capacity. He began, too, in a very favourable environment, his father, D. G. Ritchie, professor of logic in the University of St. Andrews, though he died rather young, being still gratefully remembered as the most brilliant writer among Scottish philosophers at about the turn of the century.

Alexei Abrikosov

ALEXEI ABRIKOSOV has been awarded the title of Hero of Socialist Labour by the Government of the U.S.S.R. Prof. Abrikosov has just celebrated his seventieth birthday. He is a leading specialist in pathological anatomy. He has been successful in combining a theoretical subject with the practical work of a clinic, and was the founder of a new anatomico-clinical branch of pathological anatomy. At the very beginning of his career, Prof. Abrikosov studied the relationships between disease-bearing micro-organisms and the protective powers which the human organism possesses. Allergy, one of the complex problems which arise from this, naturally attracted his attention. He has carried out extensive research on the morphology of the vegetative nervous system and its pathological condition. Applying methods of pathological anatomy, he has made a detailed study of the morphological changes which take place in the tissue as a result of metabolic disorders, avitaminosis and hypo-vitaminosis For many years Prof. Abrikosov was at the Botkin Hospital, one of the largest in Moscow, and for twenty-five years has held the chair of pathological anatomy at the First Moscow Medical Institute. He was awarded a Stalin Prize for the two volumes already published of a work on pathological anatomy. Prof. Abrikosov still continues active research and teaching.

Research Development and Tax Relief

IN his Budget speech last year, the Chancellor of the Exchequer undertook to provide reliefs of income tax for industry and agriculture during the reconstruction period after the War. A Bill to give effect to these proposals has now been introduced in the House of Commons. So far as scientific research is concerned the allowance given in the Finance Act 1944 (see *Nature*, May 6, 1944, p. 542) is now to be extended to payments made after April 6, 1944. An allowance is also to be made for expenditure for buildings, plant and machinery for research incurred after January 1, 1937. Other proposals are concerned more directly with industry. Allowances are to be made for second-hand as well as new plant. A welcome sense of the well-being of personnel is shown by the inclusion, among industrial buildings qualifying for allowances, of those concerned with welfare, such as sports pavilions. An annual allowance for a period of years is proposed in respect of capital expended on purchasing patent rights after "the appointed day", and a corresponding charge is to be made against vendors of a patent. Agricultural buildings and works will qualify for allowances,

as will also houses built for workers at mines or oil wells which will be useless when the mines or wells are exhausted. The new allowances will apply to expenditure incurred since April 1, 1944.

University of Birmingham

AMONG other matters dealt with by Dr. Raymond Priestley, vice-chancellor of the University of Birmingham, in his annual report to the Court of Governors, is the part to be played by the universities in making possible the great increase of exports of Britain which will be a vital necessity for us in the post-war world, when a premium will be put on industrial efficiency in every field One contribution is through the production of an increased flow of engineering graduates of the finest possible quality, from among whom will be found not only the professional engineers of the next generation but also men to fill high executive positions in industry. With this object the University of Birmingham is seeking to rebuild and re-equip its Departments of Mechanical and Electrical Engineering. The private appeal to local firms last year for £250,000 has already met with a gratifying response. No specialization can be admitted in the undergraduate stage, though fundamental work in the University engineering laboratories must be supplemented by vacation courses in industry itself Nevertheless, something more than this preparation is needed by those among our best engineers whose aptitude and potential capacity attract them to administrative and managerial functions.

A gift from Messrs. Joseph Lucas, Ltd., of £112,000, under a seven-year covenant, for the establishment and maintenance of a chair and University lectureship in production engineering, gives a prospect of meeting the need. The University of Birmingham, which serves an area containing the largest concentration of the engineering and metal-working industries in the United Kingdom, is in every way suited to be the home of this development, and the University has agreed to institute a postgraduate course in production engineering, at present to be contained in the Department of Mechanical Engineering. The objects of the new development are to foster through research the full development of every aspect of the science of production engineering and the education through special postgraduate courses of a supply of men who possess not only a sound grasp of the fundamentals of engineering but also a specialized knowledge of production methods and processes and the varied aspects of organization and control. Such a course considerably lengthens the period of engineering education in these special cases, and problems of maintenance of students will be involved. To finance this aspect of the scheme through the first few years, Sir Peter Bennett has generously given £10,000.

Development of the Oil Industry

AT a meeting of the Manchester University Branch of the Association of Scientific Workers on February 1, Dr. H. Steiner gave a lecture on the development of the oil industry Oil was first produced industrially in 1859, when 300,000 gallons were obtained; by 1938 the production of crude oil had risen to 70,000 million gallons. In the last century the most important product was kerosene; since 1900 the advent of the motor-car has shifted the importance to the lighter fractions of the crude—mainly petrol. Due to the increased demand for the light fraction, production became unbalanced, in that too much high- and too little low-boiling fractions were produced. This was remedied by the cracking process, which by applying heat and pressure, produces lower boiling hydrocarbons from the higher boiling ones.

Later, the demand arose for high-quality petrol for improved automobile- and particularly aero-engines. Branched-chain paraffins were produced which are more resistant to 'knocking' than straight chains and can be used in engines working at high compression and thus high efficiency. The first branched-chain paraffin produced commercially was 'iso-octane' (2–2–4 trimethylpentane) This is made from *iso*-butylene, a constituent of the cracking gases. To-day very large amounts of branched-chain paraffins are produced from these gases by combining *iso*-paraffins such as *iso*butane and olefines (for example, butene) in the 'alkylation reaction'.

A later development to produce high-quality petrol is cracking in the presence of catalysts, which assist in forming branched-chain hydrocarbons. The main technical difficulty is that, in the course of the reaction, carbon is deposited on the catalyst and destroys its activity. By burning off the carbon under carefully controlled conditions, avoiding overheating, the activity can be restored The most recent method employs so-called 'fluid catalysts', that is, very fine powders, which are dispersed in the hydrocarbon vapours and then passed through the reactors. On emerging from the reactors the catalyst is separated, dispersed in air and then passed through a second heated zone where the carbon deposits are burned off. It is then ready to be used again. A very important development is the production of chemicals from petroleum, mainly from the cracking gases. Finally, probably the most important synthesis is that of butadiene. Of about 600,000 tons required for the United States synthetic rubber programme, about 400,000 tons are made from petroleum, mainly by the dehydrogenation of butene over catalysts at high temperatures.

Animal Concealment and Flash Coloration

MOMENTARY display by animals of conspicuous colours followed by reliance upon procrypsis has long been known. Jenner Weir (*Trans. Ent. Soc. Lond.*, 22; 1869) directed attention to the conspicuous hind wings exhibited in flight by many otherwise cryptic moths and *Oedipoda* grasshoppers, and Lord Walsingham, in 1890 (*Proc. Ent. Soc. Lond.*, 52, 1890), suggested that the sudden change when such flying insects came to rest serves to confuse the visual impressions of a pursuing enemy. H. B. Cott, in his work "Adaptive Coloration in Animals" (1940), devoted several pages and many figures to this 'flash coloration'. An interesting new example of the principle has been described in a letter from Staff-Sergeant J. E. Marson (6th (East Africa) Inf. Bde. Workshops, E A.E.M.E., South-East Asia Command). "In Ceylon I have noted the effectiveness of the same principle as applied to certain species of spiders. The female of *Herennia ornatissima* (Doleschall) is a medium-sized spider, grey and brown above, with the underside of the abdomen and cephalothorax having brilliant yellow, orange or red markings, according to the maturity of the spider. It spins its web on rubber trees, from stumps of branches to the main trunk. The web is nine inches to a foot in length, and is very close to the trunk at all parts. The centre of the web is tubular and is fastened to the trunk by the tip of the tube. In this tubular depression, the female rests, almost perfectly camou-

flaged by the similarity of colour to the lichens which grow on the tree. If the spider is disturbed, however, a vivid red streak shoots down the trunk, as it jumps and lowers itself on a thread. The red streak stops as it alights further down the trunk with the underside of the abdomen covered. It is very difficult to follow the later part of this movement, owing to the rapid colour change. Many members of the *Eresidæ*, which retreat into their tube-like web endings when disturbed, jump when further attacked, and the same effect is produced by the highly coloured underside of the abdomen. It would appear that this colour change would once again offer protection against a foe attacking at close range."

Parliamentary and Scientific Committee

THE annual report for 1944 of the Parliamentary and Scientific Committee refers to a further increase in the subscribing membership and to the formation of a Parliamentary Action Sub-Committee, which was especially active in connexion with the Finance Bill clauses relating to research. The report includes a summary of the changes recommended by the Sub-Committee on Taxation and Research and of the proposals of Sir John Anderson in his Budget speech last April, as well as of points made to elucidate these proposals during the debate The principal recommendations in the report on Scientific Aspects of British Agricultural Policy and in the Memorandum on the Organisation and Development of Research in Great Britain issued by the Committee during the year are detailed in the report, which further refers to the preparation of a confidential memorandum on scientific attachés, and to steps taken to encourage the establishment in the Dominions of committees similar to the Parliamentary and Scientific Committee.

X-Rays in Engineering and Industry

A PAPER on this subject read before the Institution of Electrical Engineers in London on February 1 by Dr. V. E. Pullin outlines the development of X-radiography in industry and engineering from the time of Rontgen's discovery in 1895. In the first section, developments in uses and equipment up to the beginning of the present War are recorded in broad outline. In the second, the war-time development of engineering and industrial radiography, particularly with regard to Service requirements and inspection, is dealt with The third section forecasts future radiographic developments in connexion with modifications in engineering inspection and development. The author also foreshadows the trend of development in X-ray apparatus and equipment. Applications of X-ray crystal analysis in industry and the enormous progress made by radiology in the medical and surgical fields are not discussed.

The Night Sky in March

NEW moon occurs on March 14d. 03h. 51m., U T., and full moon on March 28d. 17h. 44m. The following conjunctions with the moon take place: March 11d. 21h., Mars 2° N , March 16d. 10h., Venus 12° N.; March 21d. 03h., Saturn 0 4° N.; March 27d. 05h., Jupiter 3° S. During March no occultations of stars brighter than magnitude 6 take place. Mercury is close to the sun at the beginning of the month, rising about 20 minutes after, and setting 10 minutes before, the sun then. At the end of March the times of rising and setting are 5h. 47m. and 20h. 09m , respectively The planet attains its greatest easterly elongation on March 26. Venus is a very conspicuous object in the western sky and is well placed for observation, setting at 21h. 54m. and 21h. 04m. at the beginning and the end of the month, respectively Venus attains its greatest brilliancy on March 10. Mars, a morning star, is too close to the sun for favourable observation. Jupiter moves from the constellation of Virgo into the constellation of Leo during March, and can be seen throughout the night, setting at 7h 26m. and 5h. 17m. on March 1 and March 31. The planet is in opposition to the sun on March 13. Saturn, in the constellation of Gemini, sets at 3h. 47m. and 1h. 53m. on March 1 and March 31, and is stationary on March 5. Vernal equinox is on March 21d. 00h.

Announcements

THE Committee of the Athenæum has elected the following, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services: Prof. Sydney Chapman, chief professor of mathematics, University of London; Sir Reginald Coupland, Beit professor of Colonial history, University of Oxford; Sir George Stapledon, director of the Grassland Improvement Station, Ministry of Agriculture and Fisheries, Stratford-on-Avon.

DR T. MCKEOWN has been appointed to the chair of social medicine in the University of Birmingham. Dr. McKeown, a former Rhodes scholar, has been demonstrator in biochemistry at McGill University, Poulton research scholar and demonstrator in physiology at Guy's Hospital, London, and research worker in charge of Field Social and Economic Survey, Research and Experiments Department, Ministry of Home Security.

THE Board of the Institute of Physics has authorized the formation of a South Wales Branch of the Institute which is to be centred at Swansea. The inaugural meeting of the Branch will take place at 2.30 p m. on March 10 in the Physics Department of University College, Swansea, when Dr. C. Sykes, principal of the Brown-Firth Research Laboratories, Sheffield, will deliver an illustrated lecture on "Physics in Metallurgy". Visitors will be welcome; admission is free and without ticket. Further particulars of the Branch can be obtained from the Acting Honorary Secretary, Dr. T. V. I. Starkey, Technical College, Mount Pleasant, Swansea

UNDER the title of "Medical Miscellany List K", Schuman's, of 20 East 70th Street, New York, has recently published an annotated catalogue of more than seven hundred items on various medical subjects and an appendix with more than a hundred and fifty early American inaugural theses. While all branches of medicine are represented, the subjects chiefly dealt with are anatomy, biography, epidemiology, materia medica, history of medicine, neurology and psychiatry, pathology, physiology, surgery and therapeutics. Special mention may be made of the following books: Charles Etienne's work on anatomy (1545), a French translation of Fracastorius' poem on syphilis (1753), Stephen Hales' "Statical Essays" (1731), Florence Nightingale's "Notes on Nursing" (1860) and Allwoerden's "Life of Servetus" (1728).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Ageing of Light

RED-SHIFTS in the spectra of the galaxies are usually interpreted as Doppler effects consequent on recession. Alternatively, they have been interpreted as an 'ageing' of light with time, by which the wave-length of a photon steadily increases. That the two interpretations are substantially equivalent can be seen from the following strikingly simple calculation. I adopt the kinematic model of the expanding universe.

Suppose a photon has left our own galaxy at epoch t_1, when its frequency was ν_1, and has adventured into intergalactic space. In due course it may encounter one of the receding galaxies and be scattered or reflected. I consider only the case of direct reflexion back to ourselves. Let this photon be reflected after traversing a fraction f of the radius of the universe measured at the instant of reflexion; that is, let it be reflected at epoch t_2 when the radius of the universe is ct_2 and the distance of the reflecting galaxy fct_2. Then, since the speed of the photon is c, we have

$$t_2 = t_1 + fct_2/c = t_1 + ft_2,$$

or

$$t_2 = t_1/(1 - f);$$

and the photon arrives back at our own galaxy at epoch t_3, where

$$t_3 = t_2 + ft_2 = t_1 \frac{1+f}{1-f}.$$

It is then either reflected outwards again or propagated through our galaxy unimpeded. In either case it suffers no change of frequency at our own galaxy, but moves out again into intergalactic space, there to be eventually reflected back to us, and so on. After n such external reflexions back to us, it reaches us at epoch t_{2n+1}, given by

$$t_{2n+1} = t_1 \left(\frac{1+f}{1-f}\right)^n;$$

for, as is easily shown, the fraction f measuring the mean free path will be the same at all epochs.

At the first external reflexion, the frequency ν_1 is reduced by the *square* of the usual Doppler factor

$$\left(\frac{1 - v/c}{1 + v/c}\right)^{1/2},$$

once because of its absorption by the receding galaxy and once because of its re-emission by the same galaxy. Here v, the recession velocity, is by the velocity distance law $fct_2/t_2 = fc$. Hence the frequency is reduced to

$$\nu_1 \left(\frac{1-f}{1+f}\right).$$

After n such external reflexions, its frequency is reduced to

$$\nu_1 \left(\frac{1-f}{1+f}\right)^n.$$

If now we call ν_0 its present frequency, t_0 our present epoch, we can write these results in the form

$$\nu_0 = \nu_1 \left(\frac{1-f}{1+f}\right)^n, \quad t_0 = t_1 \left(\frac{1+f}{1-f}\right)^n.$$

Hence $\nu_0/\nu_1 = t_1/t_0$ or $\lambda_0/\lambda_1 = t_0/t_1$.

Thus the wave-length of the photon is proportional to the epoch at which it is observed, independent of the value of its mean free path.

If we now pursue the history of the photon *backwards* in time, we see that as $t_1 \to 0$, $\nu_1 \to \infty$. Thus at the epoch of 'creation', $t = 0$, there is a singularity in photon-frequency. This is an inevitable converse of the phenomenon of the ageing of light with time. The result is in accordance with the views, put forward on other grounds, recently reached by Prof. J. B. S. Haldane[1].

This result is compatible with the reception by ourselves of *all* frequencies at the present epoch, including the very high frequencies of the undulatory components of cosmic rays It is thus possible that high-frequency cosmic rays are relics of the primitive high-frequency radiation.

E. A. MILNE.

Wadham College,
Oxford. Feb. 6.

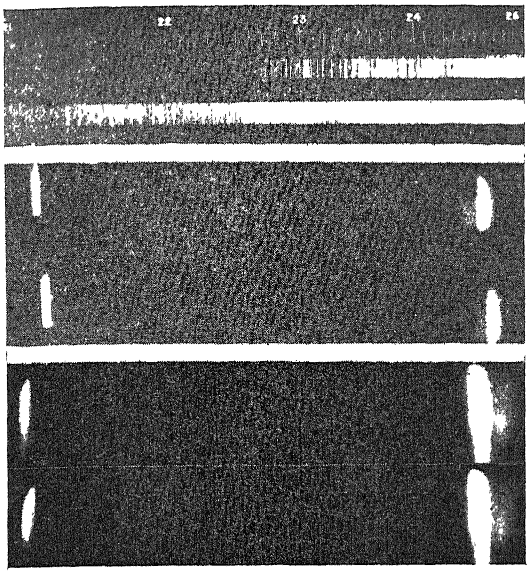
[1] *Nature*, **155**, 133 (1945)

Dynamic X-Ray Reflexions in Diamond

As was first shown by Raman and Nilakantan[1,2,3], the (111) crystal planes in diamond exhibit sharply defined reflexions of monochromatic X-rays incident on them which are distinct from the well-known Laue and Bragg effects. The same authors[3] showed that the positions of these reflexions are in perfect accord with the Raman-Nath formula derived on the basis that they arise from the quantum mechanically excited infra-red vibrations of the crystal lattice.

It has been claimed by Dr. Kathleen Lonsdale[4] that the reflexions the positions of which are given by the Raman-Nath formula are not exhibited by the kind of diamonds which are transparent to the ultra-violet up to 2250 A. To check this claim we have carried out a series of studies with a number of cleavage plates of diamond of this variety, with the result that Mrs. Lonsdale's findings are *not* confirmed. Our experiments were made with half a dozen different specimens, and we find no difficulty in recording the reflexions sought for with every one of them by giving adequate exposures. The real test whether the recorded effects are those being looked for is the dependence of their intensity on temperature. A thorough examination of this was carried out with one of our specimens (N C. 125) over a wide range of temperatures, namely, from liquid air temperature upwards to 600° C., and over a variety of settings of the crystal. Microphotometric investigations showed no noticeable change of intensity as between 30° C. and − 187° C., while there is approximately a 5 per cent increase in going up to 300° C., and about 15 per cent in going up to 600° C. These changes are in accord with the theoretical formula given by Sir C. V. Raman, if we assume that the frequency change involved in the dynamic reflexion is that of the fundamental vibration of the lattice, 1332 cm.$^{-1}$ in spectroscopic units. These results are illustrated by the accompanying photographs.

The appearance of sharply defined and intense X-ray reflexions of the dynamic kind can only be expected if the vibrations of the lattice have coherent phase relationship over a great many crystal spacings, and this in its turn evidently requires a high degree of crystal perfection The investigations on diamond by Sir C. V. Raman and others at Bangalore have



1a 1b 2a 2b 3a 3b

1a. ABSORPTION SPECTRUM OF DIAMOND (N C. 125)

1b. SPECTRUM OF THE IRON ARC

2a and 2b: PHOTOGRAPHS OF THE LAUE AND DYNAMIC (111) X-RAY REFLEXIONS WITH THE DIAMOND AT 600° C AND AT ROOM TEMPERATURE RESPECTIVELY

3a AND 3b: SIMILAR PHOTOGRAPHS TAKEN WITH THE DIAMOND AT ROOM TEMPERATURE AND AT LIQUID AIR TEMPERATURE RESPECTIVELY.

shown conclusively that the diamonds, which are throughout of the ultra-violet opaque type[5,6], possess a high degree of crystal perfection. On the other hand, diamonds of the ultra-violet transparent type have a variable crystal spacing[7], accompanied by a pronounced lamellar birefringence. It is not surprising, therefore, that the dynamic X-ray reflexions given by this type of diamond do not exhibit the same sharpness and intensity as those given by diamonds of the ultra-violet opaque kind. Indeed, even the Laue reflexions given by these diamonds often show obvious irregularities. The fact that only the most intense of the three quantum reflexions indicated by the Raman-Nath formula is observed with diamonds of the ultra-violet transparent type is also readily intelligible when the above considerations are taken into account. We have further verified that, within the limits of the error set by the imperfection of the observed reflexions, their positions agree with those given by the Raman-Nath formula.

The objections which Mrs. Lonsdale has raised against the interpretation of the X-ray reflexions observed with diamond given by the Bangalore workers are thus believed to be without experimental foundation.

R. S. KRISHNAN.
G. N. RAMACHANDRAN.

Physics Department,
Indian Institute of Science,
Bangalore.
Jan. 5.

[1] Raman, C. V, and Nilakantan, P., *Curr Sci.* **9**, 165 (1940).
[2] Raman, C V, *Proc Ind. Acad Sci*, A, **14**, 317, 332 (1941) Raman, C V, and Nilakantan, P, *Proc Ind Acad. Sci*, A, **14**, 356 (1941).
[3] Raman, C V, and Nilakantan, P, *Nature*, **147**, 118 (1941).
[4] Lonsdale, K., *Proc Roy. Soc*, A, **179**, 315 (1942).
[5] Raman, C. V., and Rendall, G. R., *Proc Ind. Acad. Sci.*, A, **19**, 265 (1944)
[6] Ramachandran, G N, *Proc. Ind. Acad. Sci.*, **20**, 245 (1944).
[7] Krishnan, R. S., *Proc. Ind Acad. Sci.*, **19**, 298 (1944).

Thermomechanical Effect in Liquid Helium II

THE peculiar properties of liquid helium II have been the subject of many experimental and theoretical investigations during recent years The characteristic features of liquid helium II are its superfluidity (viscosity less than one billionth of that of water) and the thermomechanical effect. The superfluidity has been explained by F London[1] and L Tisza[2] by assuming helium II to be in a state of Bose-Einstein degeneracy, a part of the atoms constituting the condensed phase In a previous communication[3], I have given a theory of the surface-flow of liquid helium II in the form of thin mobile films, and my purpose now is to discuss the thermomechanical effect in helium II assuming the latter to be in the state of Bose-Einstein degeneracy.

Landau[4] has given a different theory based on the model of a 'quantum liquid'. H. London[5] has given a thermodynamical discussion of the thermomechanical effect and has shown (taking the London–Tisza model of helium II) that

$$(dp/dt)_{\max} < J\rho\varphi,$$

where φ is the entropy in cal per gm., J is the mechanical equivalent of heat and $(dp/dt)_{\max}$ is an upper limit to the reaction pressure per degree. The expression for the thermomechanical effect can also be obtained as follows:

The pressure and energy per unit volume in a Bose-Einstein degenerate gas are connected by the relation

$$p_{-} = C\,\Gamma(S)\,\zeta(S+1)\,(kT)^{S+1} = \frac{E_{-}}{SV} \quad . \quad . \quad (1)$$

S is defined by the equation

$$N(\varepsilon)d\varepsilon = \frac{VC\varepsilon^{S-1}\,d\varepsilon}{1/A \, . \, e^{C/kT} - 1} \quad . \quad . \quad . \quad (2)$$

$N(\varepsilon)d\varepsilon$ denotes the number of particles having kinetic energies between ε and $\varepsilon + dc$.

As remarked by H. London, S is to be taken equal to 5 in order that the observed discontinuity in the (constant volume) specific heat at the λ-point may agree with the theoretical value.

From (1) we have

$$\frac{(dp)}{(dt)} = \frac{1}{S}\,\frac{d(E/V)}{dt} = \frac{\rho C_v}{S} \quad . \quad . \quad . \quad (3)$$

where C_v is the specific heat at constant volume (per unit mass). The above relation is roughly in accord with observations. For temperatures 1·393° K. and 1·241° K., C_v is equal to 0·311 and 0·174 respectively.

Thus we have for (dp/dt) at 1·393° K. and 1·24° K., the values $3{\cdot}65 \times 10^5$ and $2{\cdot}04 \times 10^5$, which may be compared with the observed values $1{\cdot}7 \times 10^5$ and $0{\cdot}6 \times 10^5$ respectively, corresponding to the temperatures given above.

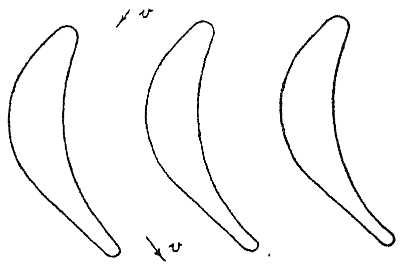
D. V. GOGATE.

Baroda College,
Baroda.
Dec. 17.

[1] London, F., *Phys. Rev*, **54**, 947 (1938).
[2] Tisza, *Nature*, **141**, 913 (1938).
[3] Gogate and Rai, *Nature*, **153**, 342 (1944)
[4] Landau, L, *Phys Rev.*, **60**, 356 (1941).
[5] London, H, *Proc. Roy. Soc.*, A, **171**, 484 (1939).

'Singing' Corner Vanes

'SINGING' in wind tunnels has been observed from time to time, and we recently had the opportunity of making a study of the phenomenon in the wind tunnel of the Aeronautical Department at the University of Sydney. This tunnel is of concrete construction, has an enclosed working section, and the aerodynamic design is conventional. The corner vanes are of the constant-width annulus type and are cast in concrete with reinforcing iron rods. The cross-section and spacing are shown in the accompanying figure



In all, seven notes were observed, and all but one of these were investigated in detail. The table lists the various notes, their origin and relevant experimental conditions. In each case, the note has a maximum intensity in the centre of the space between the cascades, where there is a strong chordwise standing wave. This standing wave is excited by either torsional or flexural vibration of the turning vanes and maintained by the alternate shedding of eddies from the trailing edges of the vanes. The phase of oscillation of alternate vanes differs by π, and the air-space oscillations are similarly related.

Note frequency (n) c.p.s.	Corner	Length of vane (l)	Air speed at corner (v)	$\frac{nc}{v}$	Elastic vibration	$\frac{nl}{\text{partial order}}$	$\frac{nl^2}{a^*}$
246	1st	7 ft.	37 f p.s.	11·5	Torsional (fundamental)	1720	—
298	1st	7	45	11·4	Flexural (fundamental)	—	651
257	2nd	8	38	11·7	,,	—	734
420	1st	7	64	11·4	Torsional (2nd partial)	1470	—
251	3rd	12	38	11 4	,,	1510	—
249	4th	14	33	13·2	,,	1740	—
280	3rd ?	12	44	11 0	Flexural (2nd partial)	—	655

*a = 22·4, 1st partial; = 61·6, 2nd partial.

That all vibrations are excited by eddies is confirmed by the constancy of the quantity nc/v, where c is the chord. The determination of the type of elastic vibration (see column 6) is made on the basis of the rough agreement with the theoretical variation of frequency with length and harmonic order, as exhibited in column 7 for torsional, and in column 8 for flexural vibrations. From the observed pattern of the sound field of the sixth note, it is certain that in this case the vanes are vibrating with a central node.

It is considered that the oscillations are due to energy transfer in the cycle: mechanical oscillation → air space standing wave → regular shedding of large eddies → forces to maintain mechanical oscillation. This cycle is made possible by the closeness of the natural frequencies of the air column between the vanes to the natural frequencies of vibration of the vanes. The comparative rarity of this phenomenon is attributed to the high damping and natural frequency of the types of vanes more usually employed. Heavy concrete vanes with ends set into concrete walls have very low damping and comparatively low natural frequencies, and calculations of natural frequencies agree roughly with the observed frequencies. In short, the occurrence of the tones is due to a fortuitous approximate equality of the resonant frequencies of the chordwise air spaces between the corner vanes, and the natural frequencies of these vanes. In this connexion, it is to be noted that speeds in the range 35–44 f.p.s. are critical for exciting the air resonance, for these and any geometrically similar corner vanes.

G. K. BATCHELOR.
A. A. TOWNSEND.

Division of Aeronautics,
Council for Scientific and Industrial Research,
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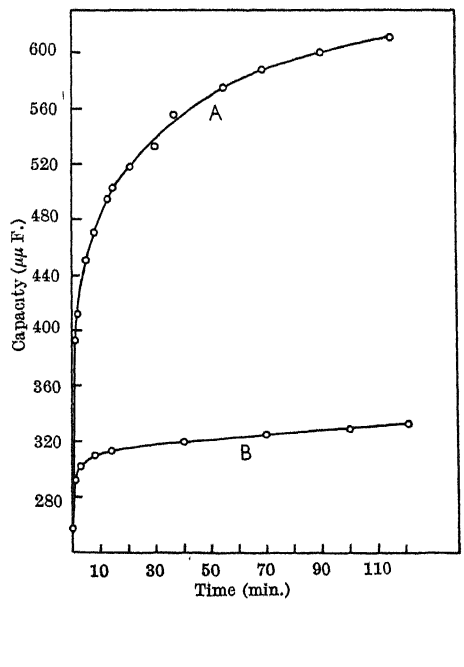
Dec. 19.

Thixotropy and Dielectric Constant of Printing Inks

INVESTIGATING the electric properties of printing inks, it was observed that the dielectric constant of an ink depends on the time it stands undisturbed in the measuring condenser. For dielectric constant determinations a commercial Philips measuring bridge, a Philoscope, was used at frequencies 50 H and 1,000 H. The polarization capacity and the polarization resistance could not be measured.

The condenser was of ordinary cup-form, the diameter being 80 mm. for the cup and 70 mm. for the lid. Two condensers were used—one of iron and another of aluminium, with air capacity of 33 and 41 $\mu\mu$F respectively. No influence of the material of the condenser on the dielectric constant of printing ink was observed.

After filling the space between electrodes with printing ink and moving the lid it was possible to bring the capacity to definite and reproducible values. The capacity increased on ceasing the movement. The time-capacity curve following the first disturb-



ance lies highest, higher than those for the second and following disturbances. But if after several disturbances the ink in the condenser is left to stand overnight, the previous day's disturbance-time-capacity curves can be reproduced.

Two curves for a frequency 1,000 H are represented in the accompanying figure. The ink corresponding to curve *A* contained 14·2 per cent I–G carbon LT and had as a vehicle a varnish with a viscosity of 562 cp. at 25° C. The ink corresponding to curve *B* contained 12·4 per cent of the same carbon, the viscosity of the varnish being 886 cp. at 25° C. Ink *A* was much more thixotropic than ink *B*; its viscosity yield-value was 1·75 times the yield-value of ink *B* in a Couette type viscosimeter. Viscosity measurements with a viscosimeter of the type described by C. F. Goodeve[1] in combination with simultaneous dielectric constant measurements on a precision bridge would enable thixotropic properties to be related to the dielectric constant – time curve, and would make it possible to investigate the phenomenon more thoroughly. I am unable at present, however, to undertake such an investigation for lack of apparatus and funds.

A. PARTS.

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Stockholm.
Dec. 9.

[1] *J. Sci. Instr.*, **16**, 19 (1939).

Molecular Weight of Palmer's β-Lactoglobulin

PEDERSEN[1] made a thorough study, in the electrophoresis apparatus and the ultracentrifuge, of β-lactoglobulin (Palmer[2]). He found that it was a homogeneous protein of molecular weight 38,000 by sedimentation equilibrium and 41,500 by diffusion measurements[3]. Neurath and Cooper, from diffusion and viscosity measurements, quote values of 43,300 and 33,700, depending on the molecular shape. From the X-ray point of view, the limitation in the accuracy of determination of the molecular weight is the estimation of the water content of the air-dried crystal. McMeekin and Warner[4] derived a figure of 35,800 from their measurements of the mean water content and the crystallographic data of Crowfoot and Riley[5]. However, if their lowest value for the water content is used, the molecular weight is increased to 37,200. As the osmotic pressure of β-lactoglobulin solutions has not hitherto been recorded, I have now made some measurements of it.

The sample of protein, kindly supplied by Dr. A. Neuberger, had been prepared and recrystallized three times by the method of Palmer[2]. It was found to be homogeneous in the Tiselius electrophoresis apparatus. For the osmotic pressure measurements the following buffer (*p*H 5·4) was used as solvent: 0·2 *M* NaCl; 0·001 *M* Na_2HPO_4; 0·019 *M* KH_2PO_4. The amount of protein in solution was calculated from the nitrogen content, using the micro-Kjeldahl procedure and nitrogen figures of Chibnall *et al.*[6].

The osmotic pressure measurements and calculations were carried out as described in a previous note[7]. The accompanying table shows the osmotic pressure at 0°, the concentration in grams of dry protein per 100 c.c. of solvent and the molecular weight for a series of experiments. From these data the calculated mean molecular weight is 38,000, with

Concentration of dry protein (gm per 100 c c solvent)	Osmotic pressure (mm mercury)	Mol. weight
1 01	4 41	39000
1 085	4 78	38600
1·21	5·297	38950
1·26	5 74	37400
1·732	7·753	38050
2·485	10 91	38800
2 963	13 61	37100
2·963	13·46	37550
4 72	20 73	38800
6 50	30·30	36500

a standard error of 900 and a mean deviation of 700, which is in good agreement with Pedersen's value obtained from sedimentation equilibrium experiments.

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Jan. 4.

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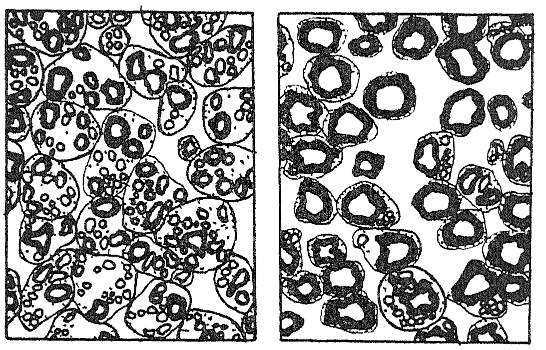
Effect of Peripheral Connexion on the Diameter of Nerve Fibres

IN recent accounts[1,2,3] of the factors which control the size reached by regenerating nerve fibres, the hypothesis has been put forward that the Schwann tubes which replace degenerating nerve fibres in the peripheral stump control the pattern of fibre sizes by the restriction which they impose on increase of diameter. In the absence of such restriction, the diameter which a regenerating fibre attains depends upon the calibre of its parent fibre in the central stump.

As a result of further experiments, it has now become clear that a third factor, namely, the re-establishment of connexion with a muscle or sensory ending, also has a profound influence on the size attained by regenerating fibres. In these new experiments both peroneal nerves of the rabbit were interrupted by crushing high in the thigh. The nerves were also cut at the knee, and on one side the cut stumps were immediately rejoined, so that functional regeneration occurred. On the other side, the lower end of the nerve was turned aside, so that the fibres formed a neuroma, having no connexion with the periphery. The animals were killed 100 or 200 days later. In the nerves which had not been allowed to make connexion with the periphery a large number of small medullated fibres was found, usually several in each of the Schwann tubes left by degeneration. The nerves which had been allowed to make normal terminal connexions contained fewer and larger fibres. Weiss and Taylor[4] have observed a similar effect; of the two parts into which a regenerating nerve was divided, that which was allowed to become reconnected with the periphery acquired larger fibres.

That length of nerve is not a factor which controls maturation was shown by a second set of experiments. In these the length of nerve to be regenerated was made short on one side of the animal, long on the other. This was done by crushing

A B



20μ

SCHWANN TUBES AND FIBRES IN THE PERIPHERY OF CRUSHED NERVES 200 DAYS AFTER OPERATION (A) WHERE THE FIBRES HAVE BEEN PREVENTED FROM MAKING ANY PERIPHERAL CONNEXION, (B) WHERE THE FIBRES HAVE BEEN ALLOWED TO INNERVATE A MUSCLE THE DRAWINGS ARE OF COMPARABLE FIELDS TRACED FROM PHOTOGRAPHS OF WEIGERT PREPARATIONS

both peroneal nerves at the same level, and lower down, cutting and joining them to the tibial in such a way that on one side the fibres were made to grow to twice their normal length. In spite of the different lengths regenerated, the fibres at a standard level below the crushed points on the two sides were found to be of similar diameter when examined 100 or 200 days after operation.

Evidently, therefore, it was the connexion with an end organ which influenced the size attained by the nerve fibres in the first experiment. When a nerve is crushed, many new fibres grow out down each of the tubes in the peripheral stump. Presumably, if one of these connects with an end organ, it hypertrophies at the expense of the others in the same tube. If no peripheral connexion is made, many begin to medullate, but none becomes large.

Such an influence of the end-organ on the nerve is probably of great importance in development as well as in regeneration, in ensuring that the nerve fibres shall come to have appropriate diameters. But the exact way in which the influence is exercised remains to be discovered; we do not know whether it depends merely upon connexion of the fibres with an end-organ, or upon the actual resumption of function by the system.

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Effects of Constant Current in Relation to 'Functional Polarity'

WHEREAS the effect of constant currents on the peripheral nerve has been thoroughly investigated, very little work has been done on the effects of such currents on the central nervous system. However, during the last few years, a number of papers has been published by Scheminzky and his co-workers. They found that the effect of passing a constant current through a frog depended on the direction of the current. While a descending current (that is, in the head-to-foot direction) produced paralysis (galvano-narcosis), an ascending current produced convulsions Scheminzky thought that it was impossible to explain this phenomenon in any other way than by a 'functional polarity', involving an assumption that the whole of the central nervous system is built up of a series of polarized elements, succeeding each other along the axis of the system. He claims to have discovered "a new law of the general physiology of the central nervous system"—a law which would be rather difficult to understand

To elucidate this problem, we at first investigated the effect of constant currents on a single centre, namely, the respiratory centre of the frog. If one electrode is put on the bulb, and the other at some point lower down on the spinal cord, a reduction of the depth and frequency of respiration is generally produced when a current of several tenths of a milliampere is passed in descending direction. An ascending current produces just the opposite effect. This evidently resembles Scheminzky's experimental results. But it is easy to demonstrate that the observed effect has nothing to do with the direction of the current; on the contrary, it depends exclusively upon the electrical charge applied to the respiratory centre. The excitatory effect of the cathode and the depressing effect of the anode on the centre remain unchanged if the second electrode is removed from the spinal cord and put on the brain, so that the direction of the current is reversed. The effect also remains the same if the second electrode is put somewhere outside the central nervous system, for example, on the fore-leg.

This fact having been firmly established, Scheminzky's observation was followed up with the same point of view in mind. We found that if one electrode is put on the spinal cord and the second electrode outside the central nervous system, the cathode on the spinal cord produced convulsions while the anode did not. A reversal of the Scheminzky phenomenon was not so easy to produce as in the respiratory centre, but finally we found a way to demonstrate it here too The effect of the current does not, of course, depend upon the place where the electrode (the end of the physical conductor) is applied; it depends on the place where the current enters or leaves the tissues to be affected, the physiological electrode. If, for example, one electrode is put on the head of the animal and the other near the cloaca, the effect on the lower extremities is usually unchanged after cutting the spinal cord, because cutting does not mean anything other than moving the physiological electrode from the brain to the place of section of the spinal cord. Now, after extirpation of a small segment of the spinal cord, if one electrode is placed, as before, on the head, and the second electrode is put on the cut surface of the lower part of the spinal cord, a perfect reversal of the Scheminzky phenomenon can be obtained: with a descending current (cathode on the spinal cord), convulsion was produced, which did not occur with an ascending current (anode on the spinal cord).

In this way Scheminzky's observation is reduced to the well-known catelectrotonic increase and anelectrotonic decrease of nervous excitability, and the stimulating effect of the cathode and the paralysing effect of the anode. The only question to be resolved was why a current passing in one direction (descending) should produce the anodic effect, and in the opposite direction (ascending) the cathodic effect. This behaviour may be explained by another well-known fact, namely, the dependence of the lower

spinal centres upon the higher ones. We know that after elimination by cutting or simply by cooling of the higher (that is to say, upper) centres, for some time at least, the lower centres may be paralysed. So, if the brain and upper centres are nearer to the anode (descending current), their anelectrotonic elimination has a paralysing effect, while their catelectrotonic excitation with an ascending current produced convulsions.

The explanation of Scheminzky's observations, therefore, needs no 'functional polarity', the existence of which is directly contradicted and refuted by the reversal demonstrated in our experiments.

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Changes in the Red Blood Cells in Chronic Infections

THE anæmias of chronic infection have not been elucidated in spite of the frequency of their occurrence. An investigation was undertaken to study the changes in the red cells in these conditions.

The following results were obtained. The red cell count is usually reduced to only a small extent. The hæmoglobin reduction is relatively greater.

In a few cases a high colour index anæmia exists In most the colour index is either normal or reduced. Analysis of the detailed characters of the red cells shows that there is a marked tendency to increase in the erythrocyte volume and diameter. The thickness of the cells, on the other hand, tends to remain within normal limits, the cells therefore being flat. Associated with this the red cells are resistant to hypotonic saline hæmolysis, and target cells are seen in blood smears in increased numbers.

The individual red cell has been shown to be hypochromic.

The absence of features suggesting excessive hæmolysis of the red cells is confirmed.

The bone marrow function appears to be reduced in respect of erythropoietic function.

The anæmia of chronic infection is therefore dimorphic, that is, there is evidence of two factors at work, one causing hypochromia and another causing increase in the volume and diameter of the cells. The macrocytosis can be related to the defective liver function demonstrated in these cases. The hypochromia is due to defective utilization of iron by the depressed bone marrow.

The level of the anæmia shows a remarkable tendency to be fixed in chronic infections. This has been attributed to the setting of the bone marrow at a new low level by the products of inflammation absorbed from the infected area

By analogy with cases of non-hæmolytic jaundice studied at the same time, it is suggested that some of the features of the red cells in the anæmias of chronic infections are due to disturbance of the normal effect of the spleen on circulating red blood cells. The anæmia of chronic infection, therefore, may be interpreted as a toxic dimorphic dyshæmopoietic anæmia with hyposplenism.

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A Crystalline Serum Muco-Protein with High Choline-Esterase Activity

IN a recent communication under the above title, we mentioned that "it appears to be an undecided question whether choline-esterases from different tissues, such as blood and brain, are identical"[1]. This cautious statement has caused Mendel, Rudney and Strelitz to say[2] that "it has definitely been established that choline-esterases from different tissues are not identical", and that they have "conclusively demonstrated" the existence of two distinct choline-esterases

While we were aware of the work of Mendel, Rudney and Strelitz, and agree that their claims may well be correct, we felt that in the present state of knowledge of this enzyme (enzymes) it seems premature to speak of them as having been "definitely established". We might recall that no electrophoretic or closer elementary analysis has yet been reported. Moreover, kinetic studies like, for example, those of Northrop on pepsin, and a study on an eventual shift of the pH-optimum in presence of different ions, appear to be necessary before such definite conclusions can be drawn Recollections of the analysis of well-known problems like the high rennin activity of crystalline pepsin, linked with elementary analysis of both rennin and pepsin preparations, the diaphorase activity of xanthine oxidase, the identity of xanthine oxidase with aldehyde oxidase, etc , make us hesitate to claim so much as Mendel *et al.*

Mendel, Rudney and Strelitz raise another point in their communication which, however, has little or no connexion with the question of the identity of the choline-esterases of brain and serum. They reported earlier the isolation of an extremely active preparation (non-crystalline) of serum choline-esterase, while we reported a less active preparation (crystalline) from the same source. Although, as can be seen from our title, we never claimed to have obtained crystalline serum choline-esterase, they argue that in comparison with their product our preparation is grossly impure. Here again we are inclined to see things more from the point of view of the many established facts which are known from enzyme studies. Crystalline enzymes, even those regarded as pure, are often less active than non-crystalline preparations (for example, Sumner's crystalline catalase and Agner's preparation); for loss of activity is often due to a more efficient removal of certain essential activators. The classical work of Sumner *et al.* showed how the presence of different ions (acetate, citrate and phosphate), as well as different substrate concentrations, were capable of shifting the pH-optimum of crystalline urease considerably, so that one and the same enzyme preparation, under slightly different conditions, but at the same pH and substrate concentration, showed a difference of activity as great as 70 per cent or more. At pH 7·5, for example, crystalline urease is at its optimal activity using phosphate buffers; whereas with acetate buffers its activity is down to approximately 15 per cent.

It seems premature, as Mendel *et al.* have attempted, to calculate how much "inert material" our crystalline preparation contains. All the more, because none of the essential characteristics of the preparations of Mendel *et al.* or ourselves (for example, pH-optimum influence of different ions, etc.) was available to make a calculation of this sort possible. These characteristics, as shown by the example of crystalline urease,

can account for very great discrepancies in activity Incidentally, we are at a loss to see any 'controversy' (a term used by Mendel *et al.*), at best there is a discrepancy, the clearing up of which will have to await the determination of the aforementioned essential characteristics.

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Acceleration of Reproduction in Terrestrial Isopoda

Mr. A. E. Needham, in one of his valuable contributions to the micro-anatomy of the Isopoda, remarks[1], "Stimulation of an ovigerous female in the region of the anterior opening of the brood pouch causes premature release of the brood and is elicited with increasing facility as incubation approaches full term".

I was greatly interested in this statement as I have accelerated reproduction in *Armadillidium vulgare* (Latr.) and several other species[2] by keeping them in a temperature slightly higher than that prevailing out of doors. Dr. H. W. Howard has obtained similar results[3]

The duration of the embryonic and larval periods seems, according to different observers, to differ greatly. Pierce[4] writes, "The period of incubation in this species [*Armadillidium vulgare* (Latr.)] is long, between fifty-six and ninety-three days, according to the varying results obtained. As no individuals were secured in copula, the exact time of its duration was not recorded. The development of the eggs may be watched from the exterior. The females should be treated very carefully."

Dr. H. W. Howard, who has had exceptional experience in the breeding of this species in connexion with his valuable work on its genetics, sends me (*in litt.*, Nov. 29, 1944) a long series of records which show the minimum period of incubation to be 39 days; the next lowest is 44 days, and the maximum 78 days, the average of the whole series being about 57 days.

Heeley[5] states, "In *A. vulgare* . . . the embryonic development is short, whilst the larval development is relatively long". He gives the average of the embryonic period as 33 days and that of the larval period as 8 days, both of which surprise me, differing as they do so strikingly from the figures obtained by Pierce, Howard and myself.

Under normal conditions (indoors) the shortest periods I have obtained are 44 + 10 days. Howard's lowest records are 39 days and 44 days.

The figures for twenty-four broods I have bred are as follows:

Number of broods	Average embryonic period (days)	Average larval period (days)	Total incubation period (days)
One	44	10	54
Four	46	12	58
One	48	12	60
Two	46	12	58
Four	48	12	60
Six	49	12	61
Three	52	10	62
Three	58	10	68

These figures refer to the shortest periods, others have exceeded by 10 to 16 days.

The idea of stimulation was quite new to me, I therefore made the following experiments. Some specimens of *Armadillidium vulgare* var. *rufobrunneus* Cllge were observed on October 1 to have formed brood pouches and on October 8 tiny eggs could be seen within. Taking a specimen between my finger and thumb on October 10, I very gently stroked the brood pouch with a very fine, small camel-hair brush. This was repeated on October 13, 15, 18 and 22. The egg membranes were burst on November 8, making a total number of 31 days for the embryonic period. The larval period occupied 8 days, making a total of 39 days for the incubation period. In a control experiment the embryonic period was 30 days and the larval period 8 days.

Only once have I obtained a brood in 54 days; the average of a long series being 64 days.

An examination of many of the newly liberated specimens showed them to be normal in every way and of the average size

There was a very noticeable change in the size and appearance of the eggs after the third stimulation in both series.

Under normal conditions, my experience is that the embryos of this species develop very slowly during the first fourteen or fifteen days. The most rapid changes are those made during the last fourteen days before the young leave the eggs.

To what extent stimulation might be applied in other groups of animals, without any deterioration of the young, is a subject well worthy of further investigation.

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Survival of *Fasciola hepatica* L. *in vitro*

No systematic attempts at culturing this liver fluke *in vitro* have yet been made. The survival times in published accounts are very short, and physiological work on such short-lived organisms is highly suspect Ordinary Ringer solutions were used, and the flukes lived from 5 to 12 hr.[1,2,3,4].

In the present work, which is preliminary to the study of the respiratory metabolism, a series of saline solutions were used, and the following results obtained: (1) Borates prolong survival, presumably by control of bacteria. Other controlling agents are either toxic to the worm (acriflavein, merthiolate, silver protein) or have no effect on survival times (sulphanilamide). (2) The optimum pH is 8·1–8·5, the optimum temperature 36° C. (3) Wide variations in osmotic pressure, K/Na ratio, and Ca/Na ratio have little effect on survival. (4) The presence of bile salt or peptone has virtually no effect. This is probably because of an increased bacterial flora, which borax and sulphanilamide are incapable of controlling. (5) Sugars increase survival times in the following order: fructose > glucose > galactose = maltose > lactose = sucrose. Disaccharides are thus less effective than monosaccharides, and are evidently not broken down to monosaccharides by enzyme action. Probably they are not reaching the worm's gut. (6) Ligatured worms in glucose survive essentially as long as unligatured controls. This suggests that glucose can enter through the body wall.

Flukes can be kept alive for 60 hours at 36° C. in the following solution: NaCl 150 mM., KCl 10 mM., $CaCl_2$ 1 mM., borax 6 mM., glucose 30 mM., *p*H 8·6. Survival times can be further increased by using fructose instead of glucose, and by the addition of 1/5,000 trypan blue[5], but the medium as stated is simpler and cheaper, and thus more suitable for large-scale work. A survival time of 60 hours, although disappointing, is a considerable advance upon previous records, and is adequate for preliminary tests of the effects of anthelmintics *in vitro*. Certain of these tests have been carried out, and it has been shown that carbon tetrachloride, probably the most effective anthelmintic *in vivo*, is innocuous *in vitro*.

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Control of Red Spider Mites

SINCE the discovery in 1936 of its insecticidal properties, 2 : 4 dinitro-6-cyclohexylphenol[1] has been widely used in the United States for the control of tetranychid mites. Successful control has been obtained of *Paratetranychus citri* (McG.)[2,3] and of *Tetranychus telarius* (L.) on citrus, cotton[4] and hops[5]; on all these crops damage by red spider is of considerable economic importance, and this substance is the only synthetic compound which has been successfully applied to control on a large scale. It is of interest that 4 : 4′ dichloro-diphenyl-βββ-trichloroethane (D.D.T.) is of no use as an acaricide. Later work has established that the phytocidal effect of dinitro-*ortho*-cyclohexylphenol can be diminished by use of its dicyclohexylamine salt without impairing its properties as an insecticide or acaricide.

Experiments recently carried out in the field from this laboratory have established that control of *T. telarius* can be obtained on hops and on greenhouse tomatoes in Great Britain.

The experiments on hops were carried out in Kent in September. Two proprietary dusts and one dust using kaolin as filler were used; all three dusts contained 1 per cent of 2 : 4 dinitro-6-cyclohexylphenol as the dicyclohexylamine salt, and ½ lb. was applied to each plant. Both were also applied as aqueous suspensions, and the compatibilities with cuprous oxide and copper oxychloride, and of the salt with nicotine were tested.

Treatment	Mites counted	% killed
Dusts		
Proprietary dust *A* } Dicyclohexylamine salt cont 1% 2·4 dinitro-6-cyclohexylphenol	2100	94·8
,, ,, *B* }	1630	94·3
Dicyclohexylamine salt with dinitrocyclohexylphenol with kaolin	1600	82·3
Flowers of sulphur	1780	26·6
Aqueous Suspensions		
0·05% dinitrocyclohexylphenol	2920	98·4
0·025% ,,	4500	97·0
0·025% ,,	1100	96·6
0·025% ,,	685	97·2
0·025% dinitrocyclohexylphenol + 0·5% proprietary cuprous oxide	1600	91·1
0·025% ,, + 0·5% copper oxychloride	1950	95·2
0·025% dicyclohexylamine salt with dinitrocyclohexylphenol	1140	97·9
0·025% ,, ,, +0·037% nicotine	780	93·3
1% Lime sulphur	2130	65·5
Control untreated	1605	9·8

0·025 per cent of the salt as a suspension gave a 96 per cent kill against 65 per cent with a standard lime sulphur used widely by the growers. With the dusts, a 94–95 per cent kill was obtained against 27 per cent with flowers of sulphur.

The mortality was only slightly reduced by the addition of cuprous oxide, copper oxychloride and nicotine.

It was further found that 60–70 per cent of the eggs were killed by application of 0·025 per cent suspensions of the dinitro compound and of its mixture with the dicyclohexylamine salt.

Experiments to compare the use of dinitrocyclohexylphenol and of its mixture with the dicyclohexylamine salt and the ammonium salt of 2 : 4 dinitro-*ortho*-cresol in killing *T. telarius* on greenhouse tomatoes in October, showed up markedly the superior properties of the dicyclohexylamine salt under conditions where plants are liable to be easily damaged. It was found that on tomatoes, satisfactory cover of the foliage could not be obtained without the addition of a wetting agent.

Treatment	Mites counted	% kill	Damage to plants
0·03% dinitrocyclohexylphenyl	109	77·1	Very slight
0·006% ,,	194	87·6	Slight
0·012% ,,	795	88·0	Some severe damage
0·025% ,,	—	—	Plants killed
0·006% ,, with the dicyclohexylamine salt	561	66·3	Slight
0·012% ,, ,, ,,	725	90·1	Slight
0·025% ,, ,, ,,	524	91·0	Slight
0·018% dinitro-*ortho*-cresol	—	—	Plants killed
0·036% ,, ,, ,,	—	20	Plants killed

Ammonium dinitro-*ortho*-cresylate killed the plants completely at dosages too small to be lethal to the red spider mite. 0·025 per cent of dinitrocyclohexylphenol as the salt gave a 91 per cent kill and caused insignificant damage, while the same concentration of the free phenol killed the plants.

Preliminary experiments with *Oligonychus ulmi* Koch on damsons have given similar promising results.

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Control of White Rot in Onions

WHITE rot in onions and other *Allium* species has been recorded in many countries and has increased in severity in England during recent years. The disease is caused by the fungus *Sclerotium cepivorum* Berk., which survives for several years as sclerotia in the soil, and is therefore difficult to control by cultural methods. Ogilvie and Hickman[1] obtained satisfactory control by broadcast applications of a proprietary fungicide containing hydroxymercurychlorophenol; but this treatment did not come into general use, possibly on account of the high cost. Apart from this, no direct control method has been recommended.

In trials made during 1943 and 1944, mercurous chloride (calomel) showed promise as a means of controlling white rot in spring-sown onions, var. James' Keeping. The best results were obtained by the

application of 4 per cent calomel dust to the seed drill at the time of sowing. The drills were opened, the dust was applied and roughly mixed with the soil. The seed was then sown and the drill closed. One pound of 4 per cent calomel dust to 50 yd. of drill appeared sufficient for salad onions raised from March sowings, but 1 lb. per 25 yd. gave better results on bulb onions grown from seed.

Full details of these trials will be published elsewhere, and in view of the prospect of controlling this obstinate disease by an economical direct method, the work is being continued and extended in 1945.

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[1] Ogilvie, L., and Hickman, C. J., *Rep. Agric. Hort. Res. Sta. Bristol for 1937*, 96 (1938).

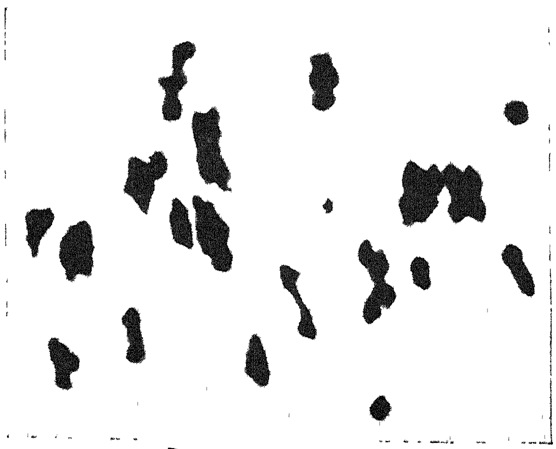
'Bolters' in Potatoes

Carson and Howard in their recent letter[1] consider the possibility that the 'bolter' sport which occurs in many varieties of potatoes is due to chromosome abnormality—excess or deficiency. Their examination of root tips, however, forces them to conclude that there is no chromosome difference between 'bolter' and normal.

Experience has shown that critical study of small chromosomes can only be made at meiosis, using a technique which does not allow contraction[2]. Again the possibility of chromosome loss in roots which need not occur in the germ track must not be overlooked[3,4].

From material supplied by Dr. McIntosh, Edinburgh, and Mrs. McDermott, Sutton Bonington, I have examined normal and aberrant types among the varieties Gladstone, Doon Star and Majestic. While there are no gross chromosomal changes, a small fragment was observed at meiosis in the 'bolter' types but in none of the corresponding normal or, for that matter, 'wilding' types. The accompanying illustration shows this fragment in a 'bolter' form of Gladstone. It is too small to determine whether it is euchromatic or heterochromatic.

It seems likely therefore, although not yet certain, that the mutation is due to the production of this fragment which, of course, will be similar in its effects to the mutation of a group of genes such as Carson and Howard infer from their breeding results. The observation of the fragment, if it is responsible, will, however, facilitate the study of the mutation.



Photograph showing extra fragment (smallest fragment, in centre) at meiosis in a 'bolter' form of Gladstone. Acetocarmine squash Thomas method[2] × 2000

I am much indebted to Mr. S. Revell for technical assistance in this work.

P. T. Thomas.

John Innes Horticultural Institution,
Merton, S.W.19.
Jan. 9.

[1] Carson, G. P., and Howard, H. W., *Nature*, **154**, 829 (1944).
[2] Thomas, P. T., *Stain Technology*, **15**, 167 (1940).
[3] Janaki-Ammal, E. K., *Nature*, **146**, 839 (1940).
[4] Darlington, C. D., and Thomas, P. T., *Proc. Roy. Soc.*, B, **130**, 129 (1941).

Effect of Controls on Stability

During the War the introduction of governmental controls has led to many matters being dealt with by an order *fixing* some quantity, price or other variable where a *laissez-faire* system would have allowed them to find their own levels. As examples we have rates of foreign exchange, wages and prices. Not only has this fixing occurred in many instances during the War, but a further extension of control or planning in peace will probably lead to even more variables being fixed in this way.

It is the purpose of this communication to point out the danger that in any dynamic system the fixing of one variable may render the rest unstable; and it will be shown that there is one type of variable particularly likely to lead to this result. (In a social or economic system the change to an unstable state would be shown by the subsequent growth of various peculiar and undesirable 'vicious circles'.)

The theory may be shown in the following way: a dynamic system in general, of n variables, has equations of form

$$\frac{dx_i}{dt} = f_i(x_1, \dots, x_n) \quad (i = 1, \dots, n).$$

Near a point of equilibrium (at which the fluxions are zero) the equations may, without serious loss of generality, be considered linear:

$$\frac{dx_i}{dt} = a_{i1} x_1 + a_{i2} x_2 + \dots + a_{in} x_n \quad (i = 1, \dots, n).$$

For a system to be stable at the equilibrial point, it is necessary and sufficient that the real parts of the roots of the equation

$$\begin{vmatrix} a_{11} - \lambda & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} - \lambda & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} - \lambda \end{vmatrix} = 0$$

are all negative. (Since we are discussing an actual system, the quantities a_{ij} will all be real.) Further, since we are discussing an equilibrial point which has existed for some time under free conditions, we may suppose it stable.

Now suppose we fix x_n. The stability of the remainder will depend on the real parts of the roots of the equation

$$\begin{vmatrix} a_{11} - \lambda & a_{12} & \dots & a_{1,n-1} \\ a_{21} & a_{22} - \lambda & \dots & a_{2,n-1} \\ \dots & \dots & \dots & \dots \\ a_{n-1,1} & a_{n-2,2} & \dots & a_{n-1,n-1} - \lambda \end{vmatrix} = 0.$$

The stability of the first system by no means implies the stability of the second system. It is clear, then, that fixing a variable may render the rest of a system unstable.

As a numerical illustration, the system

$$\left.\begin{array}{l} \dot{x}_1 = 6x_1 + 5x_2 - 10x_3 \\ \dot{x}_2 = -4x_1 - 3x_2 - x_3 \\ \dot{x}_3 = 4x_1 + 2x_2 - 6x_3 \end{array}\right\}$$

leads to the equation

$$\lambda^3 + 3\lambda^2 + 26\lambda + 60 = 0 ;$$

and this has roots $-2 \cdot 44$, $-0 \cdot 28 \pm 4 \cdot 95\, i$, where $i = \sqrt{-1}$. The real parts being all negative, the system is stable. But if we fix x_3, we have a system with determinant

$$\begin{vmatrix} 6 & 5 \\ -4 & -3 \end{vmatrix} ,$$

and as the roots are now $+1$ and $+2$, the system is unstable.

We can, however, go further than this Since the sum of the roots is equal to the sum of the elements in the main diagonal, Σa_{nn}, any change making this less negative will tend to make the system less stable —other things being equal (the argument here is admittedly imprecise). So the fixing of x_n would be particularly likely to lead to instability if a_{nn} was large and negative. We can identify such variables without difficulty; for, as they behave in accordance with the equation

$$\frac{dx}{dt} = \zeta + ax,$$

where ζ is independent of x, but changes with time, while a is large and negative, such a variable (x) will always have the properties that (1) it always moves towards $-\zeta/a$, (2) it moves towards $-\zeta/a$ *quickly*, (3) as $-\zeta/a$ has a as denominator it will be small, and therefore the fluctuations of x will be small.

It is concluded, therefore, that: (1) To fix a sociological or economic variable by order carries some danger of rendering the system, or parts of it, unstable (the latter being shown by the subsequent development of various 'vicious circles'). (2) The type of variable more particularly dangerous from this point of view is one which, under free conditions, changes value at high speed, and, by these quick changes affecting the other variables, fluctuates only through a narrow range.

Not being an economist I cannot give detailed instances, but I have little doubt that some could be provided.

W. R. ASHBY.

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Vibrations in Telegraph Wires

WALKING near Winchcomb on December 27, we noticed a most curious phenomenon. We were in a slight valley, and the road was crossed by a line of telegraph wires, there being two wires some distance apart. It was about 10.30 a.m. and the sun, shining on the wires, was just beginning to thaw the layers of frost on them. The temperature of the air must have been round about freezing-point, and there was a slight mist. But we felt no breath of wind whatsoever, nor did the dead leaves of trees very near the wires indicate any wind.

But when we arrived on the scene, the wires between two of the poles were vibrating in a very odd manner. The effect was startling as there was no other noise in the neighbourhood, and there appeared to be no cause whatsoever. The wires vibrated with about 4 nodes in them, and with amplitude roughly half an inch; frequency approximately 10 a second. The vibrations went through maxima at irregular intervals, about 2 seconds apart, and we think both wires vibrated independently. The layer of frost was slowly coming off the wires, though some pieces circled round for several minutes. The cause of the vibrations seemed to be the section of the wire just being thawed, and though the vibrations were, of course, transmitted to the neighbouring sections, all the rest of the wire was quite normal. The poles on either side shook considerably, and the effect of putting one's head against them was very like that of being in a bus. But there was no earthquake, all other objects, trees or fences, being quite still. The vibrations were decreasing in amplitude about 10 minutes after our arrival, and when we returned after half an hour, they had ceased completely.

We feel sure an explanation of this phenomenon must involve the layer of frost round the wire. The only suggestion we can make is that when the layer was formed, considerable strains were set up in the wire. When it thawed, the strains were relieved suddenly in various small parts of the wire, each time giving the vibrations a small impulse. There must then be enough such impulses to maintain continuous vibrations. But this theory does not appear very plausible to us. Also we do not think electrical impulses from heavy currents could possibly account for the effect.

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Jan. 2.

WITH reference to the above communication, we offer the following explanation.

This is a case of self-excited vibration. It would appear that the cross-section of the wire was noncircular due to the secretion of an ice-layer. The cross-section will resemble a short icicle.

If the wire achieves a small downward velocity, and a very slight wind be blowing, aerodynamic reasoning indicates that a force in a downward direction may result. Thus the motion continues, until the elastic forces in the wire stop it. There being now no downward motion, there is no downward force, and the wire commences to rise, in which motion the wind again helps Thus large vibrations may be set up.

The effect, commonly known as 'galloping', occurs moderately frequently in cold climates; but is rare in temperate zones.

Further information is given in "Mechanical Vibrations", by Den Hartog, p. 343; and the fiftieth James Forrest Lecture delivered by Prof. C. E. Inglis at the Institution of Civil Engineers in 1944.

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X-RAY EQUIPMENT FOR CRYSTALLOGRAPHY

ON November 25, 1944, a meeting of the X-Ray Analysis Group of the Institute of Physics was held in the Physics Department, University of Leeds. The meeting was opened by the chairman of the Group, Sir Lawrence Bragg. Sir Lawrence said that the necessary equipment and assistance had been found for scientific men to carry out emergency programmes of war-time research, and this must be extended in post-war planning. As the progress of crystallography is conditioned by the provision of equipment, it had been decided by the X-Ray Analysis Group to bring manufacturers and users together to discuss design and development, so that in the future suitable apparatus might readily be available.

The first two papers were on the development of the demountable X-ray tubes of Messrs. Metropolitan-Vickers Electrical Co., Ltd., and were presented by Dr. R. Witty and Mr. P Leech. In the first paper, Dr. Witty spoke about the firm's standard demountable crystallographic X-ray tube, and emphasized the two points on which differences of opinion have been found among the users of the tubes, namely, the automatic gear of the instrument and the stability of the electron emission of the filament. He agreed that early types of automatic gear caused some trouble and loss of time, but considerable improvements have been made during recent years. Filament current will be stabilized either by galvanometer or electronic relays. Mr. P. Leech then spoke about the rotating anode tube with a seal of the Muller-Beck type which is being designed for post-war manufacture. A shielded filament tube is being contemplated to overcome the deposition of tungsten on the target. Ancillary spectroscopic equipment is being designed including low-angle, Weissenberg and high-temperature cameras.

Mr. R. A. Stephen, of Messrs. Philips Lamps, Ltd., drew up a series of specifications for a sealed-off X-ray tube. He said that multi-anode tubes cannot be manufactured at present because of mutual contamination of surfaces. Single-target tubes of copper, cobalt, iron, chromium, molybdenum and tungsten are made; but zinc and manganese targets cannot be used because of the high vapour pressure of these metals. The characteristic radiation output is given by the equation $P = K(V - V_c)^{1\cdot 65}$, where V is the applied and V_c the critical radiation voltage. This holds for kilovoltages up to four to five times the excitation voltage of the characteristic radiation. In a good vacuum the insulation is estimated as about 10–20 kV. per mm. A word of warning was given about the use of unknown transformers with self-rectifying tubes, as this may put high electrical strain on the instrument due to the suppressed wave. X-ray windows are usually of 0·12 mm. Lindemann glass, which is capable of standing the required mechanical strain; but it must be carefully shielded from electron bombardment. Beryllium windows are in use, and a beryllium alloy (containing up to ½ per cent titanium) is being investigated as a window material. These metals have the advantage of not requiring to be screened. Figures of absorption of these different materials were compared. Traces of water vapour in the sealed-off tube cause the formation of tungsten oxide on the filament, and evaporation of the oxide and subsequent reformation of water vapour give a reversible reaction which produces deposits of tungsten on the target 10,000 times greater than would be expected. It is therefore essential to use a 'getter' during the life of the tube. The design of a shielded filament was discussed. The minimum safe diameter of a crystallographic X-ray tube with a Lindemann glass window was given as 60 mm. The maximum tolerance loading per unit area of a target is given by the equation

$$T_M = \frac{2W}{\pi k} \{a \log (b/a + \sqrt{1 + b^2/a^2}) + b \log (a/b + \sqrt{1 + a^2/b^2})\},$$

where W is the watts per cm.² on a rectangular focus $2a \times 2b$, T_M is maximum temperature permissible in the target, and k the thermal conductivity of the anode.

Mr. Stephen then discussed the design of the line focus. The usual size is 12 mm. × 1 2 mm. and this gives an effective focal-spot size of 1 2 mm. × 1·2 mm. when the beam is taken off the anode at an angle of 6° to the line focus. If crystallographers were to standardize spectrometer design, then it might be possible to build a tube with a line focus 36 mm. × 1·2 mm. This would give an effective spot-size of 3·6 mm. × 1·2 mm., which would be admirable for use with a slit-type collimator. With a monochromator this beam could be concentrated further into an area of either 1·2 mm. × 1 2 mm. or 3·6 mm. × 0·4 mm., depending upon the direction of reflexion of the beam from the crystal monochromator.

Dr. D. P. Riley, of the Cavendish Laboratory, Cambridge, read a paper on monochromators. Slides were shown of X-ray pictures of liquids with spurious lines due to the characteristic absorption of reflexion of part of the white radiation. These false intensity peaks were shown to be absent when a beam of radiation from a monochromator is used. In designing a monochromator the crystal should be capable of rotation and also a lateral movement parallel to the axis of the tube. A crystal used as a monochromator should reflect a strong beam of sufficient breadth to bathe the sample under investigation. The crystal, which should not be mechanically deformable, should have a reflecting face of 3–5 mm.². It should also have a high F value, be mosaic but not polycrystalline, and should be reasonably stable to heat, humidity and X-rays. It was said that planes with low Bragg angles are best, but the reflexion must be clear of the main beam of X-rays. Examples of monochromators were given. In using reflected radiation, a beam of wave-length λ may also contain harmonics λ/2, λ/3, etc., which arise from the white radiation. The reflected radiation is seriously polarized, and this gives rise to difficulties in intensity calculations on reflexions. It was suggested that tube manufacturers should be asked to give some idea of the state of polarization of the X-ray beams from the tubes they supply. For low-angle work a perfect reflector such as calcite, giving a very sharp beam, is better than a mosaic crystal of the pentaerythritol type.

The discussion was opened by Sir Lawrence Bragg, who urged that if automatic gear is produced it should be really 'foolproof', and that some 'figure of merit' of an X-ray tube should be given by the manufacturers. He also asked that information as to the best form of monochromator should be made available. Dr. H. Lipson (Cavendish Laboratory, Cambridge) asked for greater co-operation between

designers and users; he stated that the filament life in a Metropolitan-Vickers tube is 300–500 hours. Dr. Witty replied that magnetic and electric automatic gear should be 'foolproof'; vacuum relays are being improved, but are more of a problem. Dr. W. T. Astbury (Textile Physics Laboratory, University of Leeds) said that the inventing scientific worker gets little return for his efforts and is often himself held up for lack of apparatus. He believed that for further progress in design, automatic gear in experimental tubes should be kept down to a reasonable minimum. Dr E. Green (Unilevers, Ltd.) directed attention to a Russian X-ray tube in which a spirally-grooved rotating anode acts as its own molecular pump. Mr. H. P. Rooksby (General Electric Co., Ltd.) described briefly a demountable X-ray tube which has been in continuous use at his laboratory for ten years. Dr. I. MacArthur (Textile Physics Laboratory, University of Leeds) suggested that a monochromator might be placed inside the X-ray tube to produce a maximum intensity. Dr. A. Taylor (English Electric Co., Ltd.) said that from a sealed-off X-ray tube a beam has been obtained in which iron lines have been found present due to the evaporation of iron from a filament lead on to the target of the tube.

Dr. W. T. Astbury opened the afternoon session with a description of the high-output X-ray tubes which have been developed in his laboratories. The rotating anode tube has been evolved in three stages. It has a rotating copper target with a mercury seal and the body is stainless steel. Two difficulties were anticipated with this type of instrument. The first was the stability of the rotating mercury columns. An equation of the overall height of the mercury meniscus rotating with an angular velocity Ω and of internal and external radii a and b is given by

$$h = \frac{\Omega^2 a^4}{g(b^2 - a^2)^2}\left[\frac{b^4 - a^4}{2a^2} - 2b^2 \log_e b/a\right] \simeq \frac{\Omega^2 a\delta}{3g}\,(1 - \delta/2a), \text{ where } \delta = (b - a).$$

When $\Omega = 500$ r.p.m., then $h = 0{\cdot}3$ in. for the inner and $0{\cdot}45$ in. for the outer rotating system, which agrees near enough with observations. In the latest instrument $(b - a) = \frac{1}{8}$ in., but this can be reduced. Thus it can be said that the mercury column is stable. The second difficulty is evaporation from the mercury into the vacuum, but this has been eliminated by covering the meniscus with a layer of Apiezon oil, and no contamination of the vacuum chamber or anode then occurs. Dr. Astbury described how the first instrument was designed as a gas tube, this was then modified to contain a filament source. The third tube was a completely re-designed instrument which ran at 70 milliamperes and 30 kV. This is the limit of the high-tension equipment at the moment available, but there is no reason why much higher currents should not be used.

A much simpler and cheaper moving target tube has been designed which will be within the reach of any research worker requiring beams of reasonably high intensity. The instrument is continuously evacuated, and the anode is a flat hollow bar (through which runs the cooling water) which oscillates backwards and forwards at three complete oscillations per second. The vacuum seal is made by means of a tombac bellows at each end. A second and slower motion is given to the bar to vary the position of the instantaneous zero of the main oscillation and thus prevent the development of hot spots during running. Alternative methods of sealing the vacuum joint of the oscillating anode were suggested. Dr. Astbury visualizes a long oscillating tube incorporating a series of anodes all sealed by a single pair of bellows and operated from the same pumping system, and each having two windows. (At the time of the meeting the instrument had not been developed to the stage of giving an X-ray beam, but since that time the tube has run steadily at 45 milliamperes and 30 kV. and very good photographs of ramie have been taken in 2 minutes with a $\frac{1}{2}$ mm. collimator and a distance of 2 cm. (see *Nature*, **155**, 108; 1945).

Dr. I. MacArthur reviewed the development of moving-target tubes, and gave special prominence to features such as continuous cooling and vacuum seals in the instruments. The main point is not the overall power of the tube, but rather the maximum loading per unit area of the focal spot. This is determined by focusing, which might be improved by the electron gun method as used by Siegbahn, or by magnetic means. A clean target is also necessary; tantalum filaments were found to be less likely to sputter the anode than tungsten, although they have a shorter life. Dr. MacArthur referred to the possible use of the rotating anode as a molecular pump. He warned would-be makers of rotating anode tubes against porosity in vital metal parts.

Replying to questions by the chairman in the discussion, Dr. Astbury said that the rotating anode of his tube can be changed easily without draining away the mercury, and that at 70 milliamperes and 30 kV. the tube is 8–20 times as fast as a normal Philips tube. Dr. Kathleen Lonsdale described the 50 kW. and 5 kW. moving anode tubes at the Royal Institution. The output of a Shearer tube running at a nominal 5–10 milliamperes and 40–45 kV. was given as 400 watts, and a comparison of the speeds of photography of a normal Phillips tube, a Shearer tube, and the 5 kW. tube was said to be 1 : 8 : 24. The Shearer tube was used with a modified Wehnelt break and an induction coil, and a good beam was said to be maintained over a period of four hours.

Mr. Stephen said that the load on a Philips tube can be increased, but this will reduce the life of the tube. He asked that collimator sizes should be standardized, and then manufacturers would be able to design tubes for special purposes; at present the normal sealed-off tube has to be used on all occasions. Mr. T. S. Millen (Metropolitan-Vickers Electrical Co., Ltd.) outlined the optimum conditions for a rotating anode used as its own molecular pump. Replying to Mr. Rooksby, Dr. Astbury, Dr. MacArthur and Dr. Green said that the porosity of the metal in the rotating anode tube is in the outer casing and not in the anode itself. This leakage is closed by coating lightly the affected parts with shellac. Replying to a question of relative positions of focal spots in the Matchlett and Philips tube, Mr. Stephen said that with $9\frac{1}{2}$ cm. cameras the extra 1 cm. distance between focal spot and window in the Philips tube is immaterial, and is necessary because the windows of the Philips tube are of Lindemann glass. Dr. A. Taylor suggested that alloy targets might be used so that with suitable choice of filters different monochromatic beams might be obtained. Mr. F. A. Bannister (British Museum) told the meeting that minerals can be readily examined using beams from Shearer tubes, the purity of radiation of which is universally accepted.

F. HAPPEY.

GRAMICIDIN S

It is now well known that Dubos and his collaborators in America (see, among other papers by these workers, R. J. Dubos and R. D. Hotchkiss, *J. Exp. Med*, **73**, 629, 1941) obtained from soil, sewage, manure and cheese, several species of aerobic, sporulating bacilli which are antagonistic to unrelated organisms, and that they recovered from these organisms an alcohol-soluble, water-insoluble fraction called tyrothricin, which kills many Gram-positive and Gram-negative organisms. From tyrothricin they isolated two crystalline polypeptides —gramicidin and tyrocidine. Tyrothricin is unsuitable for systemic administration (*Brit. Med. J.*, 122, Jan. 27, 1945), but it is a powerful local antiseptic and has been used for the treatment of wounds, affections of the eye, nose and throat, empyema, certain skin affections and other conditions not requiring parenteral administration. It is now marketed by Messrs. Sharp and Dohme, Ltd., Mulford Biological Laboratories, Hoddesdon, Herts, who issue a booklet on its history and use, with a useful bibliography about it.

Russian workers (*Nature*, **154**, 703, Dec. 2, 1944; *Lancet*, 715, Dec. 2, 1944) now report the discovery of another substance of the same kind as the American gramicidin. Prof. G. F. Gause and M. G. Brazhnikova, of the Moscow Institute of Tropical Medicine, report on their search, during 1942, among several hundreds of strains of bacteria from Russian soils for an organism similar to that discovered by Dubos and his collaborators. They often noted action antagonistic to bacteria in their cultures, but only one organism, isolated from garden soil, was remarkably effective. This belonged to the *Bacillus brevis* group and was similar to, but not entirely the same as, the one isolated by Dubos and Hotchkiss (*loc. cit.*). It produced, however, an antibacterial principle which is entirely different from that described by Dubos and his collaborators. This principle readily crystallized out when an alcoholic extract of the acid precipitate of the bacterial culture was poured on to a watch-glass, and it never occurred with the tyrothricin described by the American workers. The Russian authors regard this gramicidin as a new substance, different from other known crystalline polypeptides produced by aerobic sporulating bacteria. They call it 'gramicidin S'. Its antibacterial action against eighteen different strains of *Staphylococcus aureus*, ten strains of *Streptococcus* and against *Diplococcus pneumoniæ*, *Clostridium welchii* and *C. histolyticum* is described by Gause and Brazhnikova. Comparison of it with tyrothricin showed that gramicidin S was rather more efficient in killing staphylococci, while tyrothricin killed streptococci and pneumococci more effectively; and gramicidin S was the less selective of the two. On the other hand, while tyrothricin is not effective against any of the Gram-negative organisms studied, as Dubos and Hotchkiss (*loc. cit.*) also found, gramicidin S prevents the growth of and kills "many varieties" of Gram-negative organisms, including *B. proteus vulgaris* and *Bact. coli*, which are common in infected wounds. The former is resistant to many antiseptics including penicillin.

At the same time, gramicidin S is very stable and is not more toxic than tyrothricin, the lethal dose (L.D.50) for white rats being almost the same. Its antibacterial activity is not destroyed by autoclaving, nor do solutions of it used clinically interfere with the activity of leucocytes. Treatment by the Russian workers of lacerated wounds of guinea pigs infected with *Cl. welchii* showed that the mortality of the animals thus treated was 5 per cent, while that of untreated ones was 53 per cent. When wounds of white rats were infected with garden soil, 100 per cent of the rats died, whereas, when such wounds were treated with gramicidin S, only 40 per cent died.

In the *Lancet* (*loc. cit.*) the chemistry of gramicidin S is discussed by A. N. Belozersky and T. S. Passhina and its clinical use is described by Prof. P. G. Sergiev, vice-president of the Medical Research Council of the U.S.S.R. Sergiev describes the results of treatment with gramicidin S of three hundred cases of gunshot wounds of soft tissue, severe burns, abscesses and anærobic infections. The disappearance of necrotic tissue and appearance of granulations and epithelialization were very rapid. Gramicidin S was also useful for preparing wound surfaces for skin-grafting and for the treatment of empyema, peritonitis and impetigo.

Cytologists will be interested in the statement, in the article by Gause and Brazhnikova, that L. Levinson, of the University of Moscow, claims that gramicidin S favours regeneration of wound tissues and especially "the high nucleic acid content of the cells". If this means that the nucleic acid content of tissue cells is increased, this effect of gramicidin S merits further investigation in the light of E. Stedman's view, discussed in a recent article on the chemistry of cell nuclei (*Edin. Med. J.*, **51**, 353; 1944), that nucleic acid exists in nuclei in salt-like combination with histone and that diminution of histone from any cause might set free nucleic acid, which, by combining with chromosomin, might form a self-reproducing enzymic system analogous to the viruses with the result that, when growth reached a certain stage, mitosis would follow. Stedman suggests that histone may regulate mitosis (see also E. Stedman and E. Stedman, *Nature*, **152**, 566; 1943) and that the decrease of histone below a certain level may in this way render a cell malignant. The origin of histone is not known, but Stedman suggests that the lymphoid tissue may supply it; the nuclei of lymphocytes contain a high percentage of histone and the accumulation of lymphocytes around tumours may represent an attempt to remedy the deficiency of histone which is causing the malignancy. If this conception is correct, the confirmation of Levinson's statement that the cells of tissues treated with gramicidin S have a high nucleic acid content is desirable. For it is conceivable that the reported beneficial effect of gramicidin S upon regeneration of tissues may be due to an increase of nucleic acid caused by gramicidin S, with the result that more is present than the available histone can absorb, so that, as Stedman suggests, the excess combines with chromosomin, and cell divisions, that is, cell proliferation follow. A further result is, however, conceivable. If gramicidin S treatment were sufficiently prolonged some cells might be started off on a career of malignancy, especially if other factors were already reducing the available histone. It seems unlikely that gramicidin S itself could reduce the histone, but the possibility needs investigation. If, on the other hand, it could increase the histone, it might prove useful for the treatment of malignancy. The possibility that the American gramicidin and tyrocidin may have similar effects is also worth study. Whether similar effects can be exerted by other bacterial and perhaps fungal products can only be answered by the cytologist.

G. Lapage.

KILN SEASONING VENEERS FOR PLYWOOD MANUFACTURE

DURING the War considerable investigation and research work has been carried out at the Forest Research Institute, Dehra Dun, India, on the subject of plywood manufacture. Kiln seasoning has been studied. Two *Indian Forest Leaflets*, Nos. 57 and 61 (published by the Forest Research Institute, Dehra Dun), deal with "Furnace Heated Veneer Drying Kiln" and "Kiln Drying Schedule for Seasoning of Veneers", giving the latest practical information on these subjects. In Leaflet No. 57, after directing attention to the necessity of the thorough seasoning of veneers before gluing and manufacture into plywood, it is pointed out that green veneers can be air-seasoned or kiln-dried, exactly like ordinary wood. The usual method in Europe and America for the quick seasoning of veneers is to dry them in long progressive dryers. This well-known type of dryer is very expensive, the pre-war price being more than 50,000 rupees.

Apart from the considerable price, it was found that this dryer was not essential for the quick seasoning of veneer, especially for the cheaper forms of plywood in so great demand in India, and that cheaper forms of timber seasoning kilns could be used. Experiments in this direction were undertaken and resulted in the furnace-heated veneer-drying kiln described. This is an indirect-heated internal-fan furnace kiln, suitable for the rapid seasoning of veneers before manufacture into plywood. It has been primarily designed for the use of plywood factories in which there is no provision for the supply of steam. The kiln has plenty of heating surface to raise the temperature of the circulating air in a short time. It is provided with four fans for the rapid circulation of air necessary for successful veneer drying. Provision is made for exhausting the moist air of the kiln through chimneys in the roof and for drawing in fresh air through the fresh-air ducts. The kiln is also provided with tracks and trucks, the latter of which are loaded with the green veneers outside and then pushed along the tracks into the drying chamber. It is estimated that 1/16 in. thick veneers of mango take about three hours for complete seasoning, as compared with a few minutes in the costly long progressive dryers of Europe and America. The cost of installation of the one described is estimated at about 5,000 rupees, at July 1943 current prices.

In Leaflet No. 61 the results of experiments carried out on the kiln seasoning of veneers of mango (*Mangifera indica*), salai (*Boswellia serrata*), narikel (*Sterculia alata*) and sissoo (*Dalbergia sissoo*) are briefly described. From the results obtained for the first three of the above species, a kiln-drying schedule for the seasoning of veneers of light hardwoods, commonly used for cheap plywood, is recommended. A short description of different kinds of veneer dryers is also included.

RESEARCHES IN PLANT VIRUS DISEASES

SEVERAL workers at the Rothamsted Experimental Station have recently added to our knowledge of plant virus diseases. A. Kleczkowski (*Biochem. J.*, (2), 38, 160; 1944) has found that tobacco mosaic virus does not combine with pepsin until it has been denatured by heat. Potato virus *X*, however, is a substrate for the proteolytic activity of pepsin, and combines with it. The same virus is also a substrate for trypsin, which nevertheless combines more with tobacco mosaic virus, which is not a substrate. This action can explain the reversible inhibition of tobacco mosaic virus by trypsin. Invertase does not combine with either virus.

F. C. Bawden and N W. Pirie have found (*Brit. J. Exp. Path.*, 25, 68; 1944) that extracts of milled fibre from tomato plants infected with bushy stunt contain some virus combined with chromoprotein to form a non-precipitating antigen. The extracts would, however, precipitate with antiserum when the chromoprotein had been removed. Extracts from healthy plants to which pure virus is added are also non-precipitating.

B. Kassanis (*Brit. J. Exp. Path.*, 24, 152; 1943) has studied the mechanism of neutralization of infectivity of several viruses by antisera. Unspecific neutralization by normal and heterologous sera is great in proportion to the additional specific effect of homologous antisera. Specific neutralization could only be used to demonstrate serological relationships if sera were of the same age and subjected to comparable storage conditions. Neutralization is not caused by precipitating antibodies, and precipitin titre is not correlated with neutralizing power. Specific antisera for the sugar beet yellows virus have been prepared by A. Kleczkowski and M. A. Watson (*Ann. Appl. Biol.*, 31, 2; 1944). The virus is not affected between *p*H 5 and 9, though it is relatively unstable. It has not yet been purified, though it is reversibly precipitated by ammonium sulphate, and sedimented by high-speed centrifugation. The precipitin reaction with antisera can be applied to the crude sap, and is useful for diagnosis. Several workers have claimed that virus inactivation by formaldehyde and mercuric chloride is reversible, but B. Kassanis and A. Kleczkowski (*Biochem. J*, 38, 20; 1944) have not found this to be so with purified tobacco mosaic virus. Inactivation could be arrested at any stage by dilution or dialysis, but could not be reversed. Loss of infectivity caused by formaldehyde does not seem to depend on changes in amino-nitrogen groups.

Serological reactions and the production of intracellular inclusions have been used by F. C. Bawden and F. M. L. Sheffield (*Ann. Appl. Biol.*, 31, 33; 1944) to establish relationships between viruses causing necrotic diseases of the potato. Potato virus *B*, and some others not previously described, are strains of virus *X*, and potato virus *C* is a strain of virus *Y*. Virus *A* is not related to *Y* or *X*.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, February 24

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 11 a.m.—Discussion on "Factors Affecting the Nutritive Value of Bread as Human Food".

BRITISH PSYCHOLOGICAL SOCIETY (in Room 134, Tuke Building, Bedford College for Women, Regent's Park, London, N.W.1), at 2.15 p.m.—"Training Industrial Workers" (a) Pearl H. M King: "Some Suggestions for the Development of Personality through Industry", (b) Helen Turner "Proficiency and Skill on the Job"; at 4 30 p.m.—P M. Freeston. "Children's Conceptions of Adult Life", at 5 15 p.m.—Madeline Kerr: "The Functions of Visual Imagery in the Formation of Stereotypes".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr. D. R Barber and Mr. E. H. Amstein. "Factors Influencing the Choice of Photographic Materials for Use in Quantitative Spectrography".

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St James's Park, London, S W 1), at 3 30 p m — Mr. N Hanlon: "The Problems involved in the Establishment of a Large Works in a Country District"

Monday, February 26

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W 7), at 5 p m —Prof H W Ahlmann "Summary of Glaciological Researches, 1918-1940".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Discussion on "Location of Industry" (to be opened by Mr D. B Williamson)

Tuesday, February 27

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C.1), at 1 30 p m —Lieut -Colonel D L R Lorimer "Scenes from the Life of a Nomad People—The Bakhtiari of S W. Persia"

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 p m —Mr C A Cameron Brown "Internal Farm Mechanisation".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m —Sir George Dyson "The Origin and Development of Early Musical Forms", (3) "The Age of Bach and Handel"

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the ROYAL INSTITUTE OF BRITISH ARCHITECTS) (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S W 1), at 5 30 p m. —Dr J. W T Walsh 'The Relationship between Interior Design in Building and Artificial Illumination"

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W 1), at 5 30 p m — Mr F N Sparkes and Mr A F Smith "The Concrete Road, a Review of Present-day Knowledge and Practice"

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C.2), at 6 p m — Dr. H P. Williams "Vertical v Horizontal Polarisation"

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6 30 p.m —Lord Halsbury. "Safety Pins and Swords".

Wednesday, February 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2), at 1 45 p m.—Prof E P. Stebbing. "Erosion and Water Supplies".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p m —Mr D. I. Lawson. "Multipath Interference in Television Transmission".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S W 1), at 6 p m —Mr R. J. Cross "Design and Fabrication of Welded Magnesium Alloy Aircraft Tanks".

ASSOCIATION OF SCIENTIFIC WORKERS (HUDDERSFIELD BRANCH) (in the Technical College, Huddersfield), at 7.30 p m —Dr. D. G. Drummond. "The Electron Microscope".*

Thursday, March 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p m.—Sir Lawrence Bragg, F R.S. "Some Physical Problems of the Solid State".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Mr P Richardson: "Stray Losses in Synchronous Electrical Machinery".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S W.1), at 6.30 p m —Mr M. B. Morgan and Mr Thomas "Control Surface Design".

Friday, March 2

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at Gas Industry House, 1 Grosvenor Place, London, S W 1), at 2 30 p m — Dr. J. C. Swallow "Some Aspects of Research in the Plastics Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m —Mr. H. L Kirke. "Some Aspects of Pre-War and Post-War Television".

Saturday, March 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 2 30 p m —Annual General Meeting Mr. A. S Kennard "The Early Digs in Kent's Hole, Torquay, and Mrs. Cazalet" (Presidential Address)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby (March 5).

LECTURER IN BIOLOGY—The Director, School of Pharmacy, Robert Gordon's Technical College, Aberdeen (March 6).

BOROUGH SURVEYOR AND ENGINEER—The Town Clerk, Guildhall, Shrewsbury (endorsed 'Borough Surveyor') (March 9).

FOOD AND DRUG ANALYST for service with large Company operating in the Middle East—The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C 2 (quoting Reference No F.2894.XA) (March 12).

ASSISTANT LIBRARIAN—The Secretary, Royal Society of Medicine, 1 Wimpole Street, London, W.1 (March 15).

RESEARCH INVESTIGATOR to take charge of the section of the Research Department dealing with the CASTING OF NON-FERROUS METALS AND ALLOYS, and a RESEARCH INVESTIGATOR to take charge of the section of the Research Department dealing with the CORROSION OF METALS—The Director, British Non-Ferrous Metals Research Association, Euston Street, London, N.W 1 (March 31)

PROFESSOR OF PHILOSOPHY, tenable in the Durham Division of the University—The Registrar, University of Durham, 46 North Bailey, Durham (March 31)

KEEPER OF THE DEPARTMENT OF ANTIQUITIES—The Registrar, The University, Old Clarendon Building, Oxford (March 31)

LIBRARIAN—The Acting Registrar, Queen Mary College, c/o King's College, Cambridge (April 3)

LECTURESHIP IN GENETICS—The Secretary of University Court, The University, Glasgow (April 7)

HEAD OF THE DEPARTMENT OF HOUSEHOLD ARTS—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (April 14)

SECRETARY AND REGISTRAR—The Acting Registrar, University College of North Wales, Bangor (April 21)

PROFESSORSHIP OF MECHANICAL AND MARINE ENGINEERING, tenable at King's College—The Registrar, King's College, Newcastle-upon-Tyne (April 30)

SECRETARY—The Council, Institution of Naval Architects, 10 Upper Belgrave Street, London, S W 1 (May 1).

LIBRARIAN—The Secretary and Treasurer, University College, Dundee (August 31)

MASTER to teach CHEMISTRY and subsidiary PHYSICS to Scholarship standard—The Acting Head Master, Perse School, Cambridge

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield

SPEECH THERAPIST—The Director of Education, Education Offices, Moss Street, Bury, Lancs

PSYCHOLOGIST (part-time, man or woman)—The Medical Superintendent, Mill Hill Neurosis Centre, Mill Hill, London, N W.7

GRADUATE MASTER or MISTRESS to teach Inter B Sc CHEMISTRY to Evening students and SCIENCE or MATHEMATICS in Junior Day Departments—The Principal, Wycombe Technical Institute, Easton Street, High Wycombe, Bucks

TEACHER (full-time) OF METALLURGY, with CHEMISTRY as a subsidiary subject—The Principal, Enfield Technical College, Queensway, Enfield, Middx.

LECTURER IN GEOGRAPHY—The Secretary, Homerton College, Cambridge

GEOGRAPHY SPECIALIST (part-time, or full-time if able to offer a second subject which may be required)—The Principal, Diocesan Training College for Women Teachers, Ripon, Yorks

HEADMASTER OF OUNDLE SCHOOL—The Secretary to the Governing Body, Grocers' Hall, Princes Street, London, E C 2.

ASSISTANT DAIRY BACTERIOLOGIST—The Principal, Harper Adams Agricultural College, Newport, Shropshire

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Race Relations and the Schools: a Survey of the Colour Question in some Aspects of English Education, with a Number of Proposals and Questions Pp. 56. (London: League of Coloured Peoples, 1945.) [261

The Future of University and Higher Education: a Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp. 16. (London, National Union of Students, 1945) 6*d* [261

Leeds University Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1943-44 Pp 30 (Leeds: The University, 1944) [311

The Road to Security By Prof David Mitrany. (Peace Aims Pamphlet, No 29) Pp 20. (London. National Peace Council, 1944) 4*d*. [311

Imperial College of Science and Technology. Proceedings of the Conference of Industrial Representatives, No 2: Industry and University Education, convened by the Vacation Work Committee of the Imperial College Union, London, on 15th December 1944. Pp v+40 (London: Imperial College of Science, 1945.) [12

Other Countries

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 21, No 4. Die Samenbildung und die Zytologie bei Agamospermischen und Sexuellen Arten von Elatostema und einigen Nahestehenden Gattungen nebst Beleuchtung einiger Damit zusammenhängender Probleme. Von Folke Fagerlind Pp. 130. Serien 3, Band 21, No 5: A Quantitative Study of the Reflexion of X-rays by Sodium and Potassium Chlorides By J. A Wasastjerna Pp 21 Serien 3, Band 21, No 6: The Anatomy of *Labiostomella gisleni* Silén (Bryozoa Protocheilostomata), with special regard to the Embryo Chambers of the Different Groups of Bryozoa and to the Origin and Development of the Bryozoan Zoarium By Lars Silén. Pp. 111+5 plates. Serien 3, Band 21, No. 7: On the Exoskeletal Shoulder-girdle of Teleostomian Fishes, with special reference to *Eusthenopteron foordi* Whiteaves By Erik Jarvik Pp 32. (Stockholm. Almquist and Wiksells Boktryckeri A.-B., 1944.) [101

Catalogues

The B.T.L. Photoelectric Turbidimeter and Colorimeter. Pp. 8. The B.T L Universal Electric Stirrer Pp. 8 (London. Baird and Tatlock, Ltd)

A Catalogue of Books Old and Modern in various Departments of Literature. (No. 497) Pp. 38. (Cambridge. Bowes and Bowes, Ltd., 1945.) 3*d*.

NATURE

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FUNCTION OF INFORMATION SERVICES IN GOVERNMENT

THE debate in the House of Lords on January 31, on Lord Elton's motion, regarding the setting up of an organization to assume after the War the responsibility for spreading knowledge of the British Empire, a duty which is at present undertaken by the Ministry of Information, touches one particular aspect of the wider problem discussed in the Political and Economic Planning broadsheet on "Government Information Services" issued a couple of days later. The debate, in which others besides Lord Elton paid tribute to the work of the Empire Information Service, amply demonstrated the need for such educational work, as well as the opportunities, and Lord Samuel and Lord Hailey lent powerful support to Lord Elton's plea that plans should be made for continuing the work of this unit if the general work of the Ministry of Information should be brought to an end. There was division of opinion as to how best this could be achieved. Lord Elton and Lord Hailey both suggested a form of Empire Publicity Board, with strong independent representation, in association with that of Government departments, and though Lord Cranborne in replying for the Government pointed out weaknesses in such a proposal, he indicated that the importance of the question is fully appreciated by the Government and that it has been for some time under the urgent consideration of the departments concerned.

The *Planning* broadsheet is concerned with the more general aspects of the question and is a sequence to an earlier broadsheet on "The Future of Foreign Publicity" which has already been discussed in these columns. It was assumed in the House of Lords debate and also in the broadsheet on information services that the Ministry of Information will be terminated at the end of the War ; and though this appears to be accepted as right and proper, there was strong support for the view that certain of its activities should be continued in some way under Government auspices. Powerful support is to be found for this point of view in two recent and important books. Sir Victor Wellesley, in "Diplomacy in Fetters", discusses the handicaps under which foreign policy is conducted by a democracy, and makes two points which are vital to the discussion of this subject. First, the danger which uninstructed public opinion represents in the conduct of foreign affairs ; and secondly, that if the maintenance of a lasting peace is the chief objective of our foreign policy, it is essential that domestic policy should conform to the exigencies of foreign policy, and vice versa. Sir Victor proceeds to outline some constructive proposals, based on his experience as Deputy Under-Secretary of State for Foreign Affairs, to provide a new technique by which policy could keep abreast of modern requirements. With its details we are not concerned here, more than to emphasize that it involves more accurate intelligence on foreign affairs—not merely fact-finding—as a basis

for the determination of policy, and also the education of public opinion.

Mr. McCallum's "Public Opinion and the Last Peace" contains no such constructive proposals, but his review of the changes in public opinion with regard to the problems arising out of the Treaty of Versailles and the way in which these contributed to the disaster of 1939, demonstrates once again the dangers of an uneducated public opinion and also of the absence of clear, straight thinking on the part of statesmen and party leaders. Once again it is apparent that courage and honesty are the foundations of effective policy, and there could scarcely be more emphatic evidence of the importance of some official effort to guide public opinion as to what is involved in public measures and policies than in these two books

The *Planning* broadsheet drives home the same lesson, though from another point of view. The conception of government as a positive and not a merely negative function plays in this, as in other *Planning* broadsheets, an important part in leading up to the conclusions which are drawn: the Government cannot perform its larger functions in the social and economic life of the community unless it has the right and means to make its purposes and methods effectively known. That need cannot be wholly met by full reporting of Parliamentary debates, and it is high time, in consonance with democratic principle, that fuller and simpler explanations be given to the great majority of people, who have a right to know why and what their Government has done, is doing and wishes to do. Explanation cannot be left entirely to the initiative of newspapers and book publishers · the administration is entitled in the public interest to take its own view of what requires explanation and by what means the explanation can best be given. Equally it is important that Government should be kept continuously aware of the citizen's point of view.

The P E P Group which has produced "Government Information Services" has admirably fulfilled its set purpose of adding to public knowledge of this important aspect of government, evaluating criticism and drawing up recommendations for the future. The history of Government public relations departments is briefly reviewed, and the lucid analysis of current criticism and of future activities leads to proposals for their future scope and organization which are concisely summarized. While there is nothing very novel in these recommendations—the Group agrees on the whole with the view that the end of the War should see the end of the Ministry of Information—the need is emphasized for an early decision by the Government as to the way in which certain of the functions of the Ministry are to be perpetuated. Just how the centralized responsibility for public information should be discharged in peacetime may be a question to which the answer can best be found in practice. The broadsheet shows clearly that the function of Government information is not exhausted even in the adequate performance by administrative departments of their own functions.

The first P E P recommendation is that Government information services should continue after the War through departmental units. Their functions should include the provision of news and information about administrative activity and the background of policy; public instruction on appropriate themes; and advice to their Ministries on public attitudes and opinions. To avoid misunderstanding and to keep present to the minds of the officers themselves the essential nature and the proper limits of their task, the term 'public relations' should be dropped and 'information' substituted. To provide technical and creative services, P E P recommends that a central publicity unit should be set up, attached to the Treasury, the Lord President of the Council or the Cabinet Offices, and operating under the general direction of a standing committee of departmental directors of information services. The unit would take over the work of such divisions of the Ministry of Information as films, publications, photographs, exhibitions and campaigns, and be responsible for buying space, time and commodities for all Government advertising. In the production of publicity, departments should be free to deal direct with private agencies where these exist.

With regard to themes, it is suggested that, as before the War, information units should undertake publicity on such questions as health and road safety, and should also provide information about new post-war measures and policies. Fuller background information should be given on subjects of general interest such as foreign affairs and public finance. Food and works relations publicity should also continue, the latter under the joint sponsorship of Government, employers' organizations and the trade unions, with considerable devolution of control to the level of industries and factories. If the inherent dangers and difficulties can be overcome, information services in this field might do something materially to improve industrial relations and to promote the closer integration of industry with the community it serves. Furthermore, information services should cover the general nature and methods of the Civil Service and its work. A fuller and wider knowledge of the facts and reasons on the part of the public would both be a safeguard against bureaucracy and prejudiced criticism of the Civil Service and accelerate any necessary or desirable changes in the Service itself. The more light is thrown on the purposes and methods of Government departments, the less likely are obsolete techniques, sectional habits of thought and indifference to the service of the public to survive. Moreover, it cannot be doubted that if considerable changes in the machinery of government at any level prove necessary to serve our new needs, public understanding and consent will be indispensable before such changes can be implemented.

With regard to departmental arrangements, the broadsheet urges that the head of the departmental branch should have sufficient status to give him access to the Minister, and adequate authority in negotiation and conference; a rank of at least assistant secretary is proposed. While the size and

diversity of the staff must depend on the size and work of the Ministry, in general large technical staffs should be avoided; a small highly-qualified staff able to use outside services, with a chief of high Civil Service rank, is preferred. The director himself need not be a technician, but should be well qualified to buy and control the technical services involved. Initially, directors might be chosen from outside, sometimes on a temporary basis; but in due course these posts could be filled by Civil Servants with the right aptitudes and some experience in information branches.

The broadsheet also directs attention to the value of close links between information branches, departmental intelligence units and libraries. In the Ministry of Health, these have from their inception been organically related, but in other Ministries relations are casual, and there may be no functional or administrative relation between public relations and the library, the statistical branch and the intelligence branch or any of them. Indeed the broadsheet goes so far as to suggest that if Whitehall had before the War been staffed with public relations branches which knew their business, the neglect of statistics and research which marred the administrative work of some Departments of State might in part have been corrected. At this point some clear thinking will obviously be required if the proposals are not to conflict with those which have been advanced by the Council of the Royal Statistical Society in its memorandum on official statistics and which, as the Prime Minister has announced, are now to be discussed with representatives of the departments concerned at a special meeting.

Another subject which calls for further consideration is the provision of information about public opinion. The first and most important source of such information is Parliament, but the Parliamentary interpretation of public opinion needs to be supplemented, as it has been during the War, by scientific surveys of public opinion. This need may arise from administrative considerations — the Requisitioned Land and War Works Bill is a glaring instance of the consequences of administrative neglect in this respect —and while these needs may sometimes be served by limited *ad hoc* inquiries, there is little doubt that more elaborate and fundamental researches may sometimes be required.

The broadsheet is emphatic that the Government should not be deprived of the use of scientific research in this field, but is hesitant as to the method and safeguards. The results of such studies should be published, though delay might sometimes be desirable. Tentatively, it is suggested that the right answer might be to encourage the formation of a social research council or institute under the ægis of the Lord President, financed by the State, but with independent scientific status. Such a body might align itself with the work of the universities and private agencies in this field and could take charge of the official research unit. The broadsheet rightly points out that the public opinion survey represents a new and important method of investigation in the social sciences, of which the Government should not be wholly deprived; this should be sufficient answer to criticism about interference with civil liberties and spying into private affairs which have been made

Local information services are important and should be remembered in connexion with the training of local staffs of central departments. The work of the Citizens' Advice Bureaux and the war-time local information centres should continue: the latter should cover the whole province of local government and should keep in touch with the local offices of the Government. Some regional co-ordination by the central Government of its own local information activities will probably be necessary, and the machinery for this could be attached to the central publicity unit.

Finally, reviewing the safeguards against the abuses to which Government information services might be subject, such as their use to press a Government case unduly against opposition, to give unfair advantage to a political party in power, to build up the personal reputations of Ministers, and to overweight the position of the executive *vis-à-vis* Parliament, the broadsheet points to the remedies in due publicity for the nature and operations of the information services themselves; the maintenance of proper codes and standards of conduct among the information staffs; responsible use of them by Ministers; and continuous vigilance by Parliament and the Press.

The careful examination of these dangers and safeguards in the broadsheets does not warrant pessimism as to their adequacy. Vigilance undoubtedly will be required, but an independent central publicity unit as suggested may be free from some of the dangers of departmentalism and be competent to make its contribution in that important field of policy-making which increasingly calls for the work of committees of Ministers dealing with wide general spheres. This is the reason for the suggestion that the standing committee of public relations or information officers should meet under the auspices of the Cabinet Office with a secretary provided by that Office, and that the central publicity unit should be similarly affiliated. Whether or not such developments in the direction of a Civil general staff come soon or late—for there is little doubt they will come—there can be no question that Government information services rightly organized and wisely handled have an important if not an indispensable part to play in the establishment of right relations between knowledge and power, the application of scientific and technical knowledge to public policy, the elimination of prejudice and passion and the harmonization of executive action and public opinion. Scientific workers who study this lucid broadsheet, with Lord Woolton's observations at the recent British Association Conference in mind, can scarcely miss the implications it holds for one of the central problems of to-day, namely, the question as to how best the results of scientific inquiry can be translated into public policy for the general welfare of the community.

INDIVIDUALITY IN HIGHER ORGANISMS

The Biological Basis of Individuality
By Prof. Leo Loeb. Pp. xiii+711. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas; London: Baillière, Tindall and Cox, 1945.) 10.50 dollars.

THE origin and scope of this book are perhaps best indicated by the following paragraphs from the preface: "The starting point of this analysis was a series of investigations on the transplantation of normal and tumour tissues which the author and his collaborators have carried out in the course of about forty-eight years, some of which, especially those dealing with inbred strains of mice, have not yet been published. To make possible a unified account and interpretation of the various aspects of individuality, it was necessary for one person to undertake this work, rather than to edit a collective book written by specialists in the different sciences which contribute the data needed for this purpose. The method thus chosen suffers from the difficulty that a single author may not be able to treat with equal competence the problems involved; but it is believed that the unified presentation of these fields may, to a certain extent, compensate for such a deficiency.

"In the following chapters these types of individuality are analysed as to their evolution and their biological and physical manifestations.

"It is hoped that this presentation may be of interest to the biologist and to the general pathologist and that certain parts of it may be helpful even to the surgeon in the practice of tissue grafting, to the geneticist, to the student of cancer and to the immunologist; perhaps also to the psychologist and to some philosophers."

There is, however, much more in the book than might be gathered from these introductory remarks as it is, in fact, a serious and lengthy treatise on the whole subject, including its history and later developments. These are gone into in very considerable detail and a valuable bibliography, brought up to 1943, of some eleven hundred and fifty books and papers is appended.

Within the limits of a short review it is obviously not possible to give more than a general idea of a work of this size, but some points may be noticed.

In the first place, as the term 'individuality differential' and other 'differentials' are constantly used throughout the book and, as the sense in which they are used by the author may not be immediately apparent to the reader of this review, a few words on their meaning may not be out of place. It is now known that there is inherent in every higher individual organism something differentiating it from every other individual, which can be discovered by observing the reactions of certain cells and tissues belonging to one individual towards the tissues and cells of another individual of the same species. This particular characteristic the author names the 'individuality differential'; which is common to all (or almost all) the various tissues and organs of the individual. In the same way there are species-, genus-, order-, class-differentials which, together with the individuality differentials, he designates as 'organismal differentials', among which the individuality differential is the highest and finest one.

There are two principal methods by which the organismal differentials in general can be analysed: (1) by various types of transplantation, and (2) by serological methods. The author and his collaborators have concerned themselves principally with the former method, which he regards as best suited for the investigation of the individuality differential. A very large number of transplantations of various tissues into different animals are described and discussed in detail. The subjects dealt with in this way include autogenous and homoiogenous transplantations in various species, the individuality differentials of closely inbred animals, the problems and criteria of success or failure in transplantation of tissues and organs, transplantation of tissues into the allantois of chick embryos, into the brain or into the anterior chamber of the eye. The local and general reactions of the host to the transplanted tissues have also been investigated and critically discussed.

Interesting chapters deal with the phylogenetic and ontogenetic development of individuality, and with transplantation and individuality in certain invertebrates and lower vertebrates.

Another section of the book is concerned with the nature of tumours, with a comparison between the results of the transplantation of tumours and of normal tissues. The influence of heredity and of immunity on the results of such transplantations are also discussed.

In evaluating the results of transplantation experiments for the analysis of the individuality differential, the author classified these into six grades according to the degree of reaction provoked in the host by the graft and, while admitting that the method can claim only approximate exactitude, he regards it as still very helpful in comparing the results obtained if different types of individuality differentials are made to interact.

As regards serological methods, although these have not engaged the practical attention of the author to the same extent as transplantation, they are very fully dealt with in chapters on the blood groups and heterogenetic antigens, the differentiation of individuality differentials by serological methods, idiosyncrasy and anaphylaxis, and the chemical nature of organismal differentials, etc.

There is one point on which the reviewer cannot see eye to eye with the author. He says that, "While the serological tests are especially useful in the analysis of the differentials of groups of animals, such as species, genera, orders, and classes, transplantation experiments are best suited for the analysis of the differences between individuals as expressed in their individuality differentials" (p. 6), and that "serological tests are only under very restricted conditions serviceable in the detection of finer differences" (p. 8). Up to the end of last century this may have been the case, but the discovery of the isolysins by Ehrlich and Morgenroth in 1900, by eliminating species and similar complicating factors, enabled attention to be concentrated on the finer differences, and later work showed that, at any rate in certain species (for example, cattle and fowls), it is possible by means of comparatively simple serological reactions to identify with ease and certainty any one individual out of a large group of individuals of the same species, provided that none of these is closely related, thus demonstrating the extraordinarily delicate nature of these reactions. The objection, that only one kind of cell (the red blood corpuscle) is used, is met by the definition of the individuality differential which postulates the presence of this differential in all, or almost all, the cells and tissues of the individual.

A perusal of the very full and interesting chapter on the chemical nature of organismal differentials will probably convince most readers that future advances in the subject are to be looked for as the result of the efforts of serologists and chemists working in collaboration.

The author concludes with several chapters on more general aspects of the subject, dealing with psychical-social individuality, individuality and the world, and the evolution of individuality. These, however, come more within the sphere of philosophy and are outside the competency of the reviewer.

This book, which embodies the life-work and thought of its author, and includes a critical and almost encyclopædic account of the work of others, will be invaluable to all workers on the subject of individuality and, in view of the wide field covered, will greatly interest many of those working on allied subjects, as suggested in the preface.

C. Todd.

STIMULATING INDUSTRIAL ENTERPRISE

Refrigeration in the Engineering Industry
Pp. xii+69 (typescript). (London: O. W. Roskill and Co. (Reports), Ltd., 1945.) 42*s*.

It is generally agreed that in the industrial organization which will follow the War it will be necessary for each manufacturer to take full advantage of any technological advances which may be applicable to his particular work. The object of the present report is to help manufacturers of refrigerating plant by pointing out to them some of the fields in which refrigeration can be applied, and conversely to help those engaged in industrial processes where refrigeration would be helpful.

The first suggestion which is offered relates to the maintenance of upper-air conditions in rooms where tests or development of aeronautical instruments, engines or components may be carried out. Here, it is evident that no one wishing to test such appliances under conditions approximating to those which they will meet in service would overlook the need for refrigeration, though it is possible that refrigerating engineers might overlook the special needs, and the potential market, of this application. What the report does is to describe, in not very great detail, the installations which have already been set up for this purpose.

Another application is to the age-hardening alloys. As is well known, after heat treatment, these alloys alter in constitution at temperatures so low as ordinary room-temperature; in many cases it is essential to use them before the age-hardening has taken place, which often means, within two hours of the heat-treatment. Now, by storing them at really low temperature, the age-hardening can be delayed, so that it becomes possible to store the articles for periods of the order of a week. The obvious gain to a manufacturer, who needs, say, a stock of rivets, is immense, if he is relieved of the necessity of matching the supply always to the demand.

There is another metallurgical field in which refrigeration may be of use, namely, in the ageing of iron and steel castings, either by removal of mechanical stresses or by accelerating the changes in constitution which occur when the metal is cooled. There is some divergence of practice in this subject, and the conclusions reached by several workers are outlined in the report. It is noticeable that all the descriptions and references are taken from the work of practical engineers, that of physicists and the more academic metallurgists being ignored. It is probable that more careful consideration of their results and conclusions would either reconcile or explain the divergences of practice mentioned.

The older method of making a shrink fit is to heat the member which is too small until it just fits the other; obviously, where the one that is too large is more easily manipulated, refrigeration can help by providing means of cooling this member until it fits the smaller. Examples of this method are given, and will no doubt suggest other cases to enterprising readers.

This part of the report closes with an account of the attempts which have been made to apply local cooling to welding-electrodes, and of other miscellaneous applications, one of which (the desiccation of air supplied to furnaces) is simply a special application of the problem of air-conditioning, an art which refrigeration engineers have certainly not neglected in the past few years.

The second part of the report reviews refrigeration plants themselves, mentioning what has been done to produce multi-stage machines and to make absorption and cold-air machines practicable. Its value will therefore be mainly to the manufacturer, and less to the purchaser or prospective purchaser of a plant, though the latter may benefit by having this conspectus of types available, and may be enabled to put his inquiries direct to a firm specializing in the kind of machine best suited to his problems.

From this account, it will be seen that the report, while offering suggestions for new work or methods of working, to manufacturers and others, does not make new, original suggestions, but simply displays for consideration the more novel processes or devices already used and described. Clearly this is a legitimate activity for business consultants to engage in, and it is apparently found to be useful, for this is at least the fourth report published by the same firm. At the same time, if these reports are useful, the question presents itself whether a much larger series, covering indeed all the main branches of technology, may be needed, and whether it would be better undertaken as a definite series under the guidance of some such body as one of the engineering institutions.

Chemists already have reviews of this sort, one for pure chemistry and one for applied, while physicists have the "Progress Reports" and the (American) *Physical Reviews*. All these publications find a ready sale, and it is at least possible that similar reviews, in which an engineer engaged in one part of the industry might rapidly survey the advances in other parts, would be equally valuable. Another means by which engineers could be kept in touch with advances in regions other than their own would be an abstract journal, but experience seems to show that engineers are not attracted by these.

If either a journal of reviews or one of abstracts is desirable, it is clearly for engineers to say which they want, how detailed the reviews should be, and how the journal should be directed. It is to be hoped that some responsible body will take up this inquiry. Meanwhile, reports such as the one under review will help to show what could be done.

J. H. Awbery.

NAMING OF THE REDWOODS

By Prof. J. DOYLE
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A GENERIC segregation of the two redwoods has recently been proposed by Buchholz[1] on grounds to be referred to later. The coast redwood, with obvious priority claim to the name *Sequoia*, remains *Sequoia sempervirens*. A new generic name *Sequoiadendron* has been proposed for the Sierra redwood, long known as *Sequoia gigantea*. Buchholz[1] rejects the possible use of *Wellingtonia* as it was earlier used, though afterwards discarded, for one of the Sabiaceæ and is thus a later homonym. In a later paper Looby and Doyle[2] expressed a general agreement with the advisability of a segregation, though they were not attracted by the choice of the new generic title. Now in many quarters, especially in California, a body of opinion objects to any change in the name of the Sierra redwood, desiring the retention of *Sequoia gigantea*. In a discussion of this subject in *Science*, Jones[3] quotes extensively from this paper by Looby and Doyle as scientific support for the necessity of a segregation and refers to the authors as botanists "who, presumably, may be safely considered free from any motives ulterior to the spirit of scientific enquiry". Having been thus dragged, as it were, on the arbitration board dealing with this vexed question, a further personal statement may be permitted

This question of the generic segregation of the Sequoias has been in mind for a long time. It was discussed, for example, with Dr. Florin of Stockholm when he visited Ireland in 1938, but at that time the evidence did not seem convincing. It is now definitely and strongly felt that this earlier conservative view was the sounder, that the later agreement with the idea of segregation was a hasty judgment and that the Sierra redwood should retain the name *Sequoia gigantea*.

Dayton[4] has reported the results of a questionnaire sent to a number of Californian botanists and foresters asking for their views on this matter. It is clear that a large majority wish to retain the old name. The objections raised, in most cases, have not, apparently, a strictly scientific basis. They amount rather to the raising of a slogan "Hands off the Redwoods", or an appeal to the Save the Redwoods League. Is the Sequoia National Park to change its name? If there are in future to be no Sequoias in that happy Eden, must it now be called the Sequoiadendron National Park? Such an approach to this question may appear unscientific; nevertheless such objections have a force and a vivid claim to sympathetic consideration from all to whom a tree, and especially a redwood, is something more than a mere name in a catalogue. For these redwoods are not ordinary trees. They are among the world's wonders. They are the possession, not only of professional botanists, but of also every forester and of every tree-lover. It is easy to appreciate the feelings of so many, who, regarding them with reverence and awe, shrink from subjecting them to the cold pedantic analysis of scientific botanists. The point is that, from the replies to Dayton's questionnaire, there is shown to exist a strong human emotional background against which the naming of these trees *must* be viewed. The evidence forcing a change of name must, therefore, be very cogent, and it is the purpose of this short article to submit that there is no such cogency. On the contrary, even apart from this background, even if the Sequoias were little-known plants, familiar to only a few specialists, it is hoped to show that generic segregation, on the basis of the evidence advanced, would be, at least among the conifers, a case of unnecessary splitting.

It may be recalled that Looby and Doyle[5], having emended Lawson's[6] early account of development in *Sequoia sempervirens*, first showed that the proembryo in *Sequoia gigantea* differed from that in the coast redwood. Buchholz[7] afterwards described differences between them in the early embryogeny and followed this shortly by his formal proposal[1] for a generic segregation. In a later paper Looby and Doyle[2] further described many differences in the earlier stages from gynospore to fertilization. This is the paper from which Jones[3] has quoted, and in which a general agreement, now withdrawn, was expressed with the idea of segregation. It is at any rate clear, without delaying on specific illustrations, that, from gynospore to early embryo, there are many differences in development in the two species.

Now the segregation as proposed by Buchholz[1] is, in fact, formally based on certain external features, on six of which special emphasis is laid But in this paper Buchholz lists also a series of differences between the two under thirty-three headings. Sixteen of these are gametophytic or embryological. Further, certain of the headings are emphasized in italics and *each* of these is claimed to be of *generic* significance Of such items only six are external features, but ten are features of development. Clearly, although not included in the formal diagnoses, these developmental differences must have considerably influenced Buchholz in proposing the segregation. "These weigh heavily," he says, "in confirming the conclusion that we are concerned here with two distinct genera." I was certainly influenced at the time by these developmental differences, and by these alone.

A little further consideration, however, shows that the use of gametophytic and embryological features as points of generic significance cannot be readily accepted. Obviously such features can seldom, if ever, be employed in the discrimination of fossil genera and, to be of value among living forms, their application to the conifers as a whole must be considered—their significance cannot be limited to the Sequoias alone. If so applied, and if *differences* are significant, are *similarities* to be significant or are such features to be used or ignored at will? Thus, almost all the stages in development, from gynospore to early embryogeny, are similar in *Saxegothœa* and *Podocarpus andinus*, some being all but indistinguishable even in detail. On the other hand, most stages in *Podocarpus andinus* differ from those in *Podocarpus nivalis*. Developmental phases in species of *Phyllocladus* and *Dacrydium* also resemble those in *Saxegothœa* and all, at least up to the early post-fertilization stage, show some remarkable similarities with *Pinus* and *Araucaria* (cf. Looby and Doyle[8]). What is the *generic* significance of such facts as these? There are intergrades in living *Podocarpus* species, between the developmental type of *Podocarpus andinus* and that of *P. nivalis*; but, if *Podocarpus* to-day were only represented by two extreme types, what would the position be? It surely is that gametophytic and embryological features may be of great value in assessing broad relationships and developmental lines within groups, large or small, but their *generic* significance is doubtful and indefinite.

The differences in development which, in fact, exist between the two redwoods may be related to another feature listed but not emphasized by Buch-

holz[1]. Although the chromosome numbers have not yet been exactly counted, it is clear enough that *Sequoia gigantea* is a normal diploid conifer type with $n = 11$ or 12, while *Sequoia sempervirens* is a tetraploid with $n = 22$ or 24. Tetraploidy is rare in the conifers, being only known to occur elsewhere, according to Sax and Sax[9], in one rather rare garden variety—var *Pfitzeriana*—of *Juniperus chinensis* and probably also in *Pseudolarix*. There may be features in the genic and chromosomic balance of the order unfavourable to tetraploidy. Certainly the constitution of *S. sempervirens* itself seems to be somewhat unstable, as shown, for example, by the great vegetative variability and by the extreme condition of seed abortion which occurs. Commercial samples, collected from natural habitats, may show only 3 per cent of good seed. A strong tendency to sterility appears also at all stages of gametophytic and embryological development, at least under Irish conditions, and considerable variations, amounting to abnormalities, occur frequently at certain phases. It is suggested, therefore, that the gametophytic and embryological features shown by the coast redwood are developments induced by the tetraploid condition and that the species is best considered as a somewhat sterile, unstable and slightly aberrant derivative from a basal diploid *Sequoia* type now represented by *S. gigantea*. It is unlikely in an angiospermic genus that a generic segregation would be proposed if a tetraploid species showed some peculiarities in development.

Since developmental features seem little suited for use as *generic* characters, segregation must be based on external features and, in fact, it is on such features that Buchholz[1] has been forced to make his formal distinction. There is, however, nothing new in the list of external differences drawn up by him. The features cited have long been familiar to systematists such as Torrey, Masters, and Pilger, and differences that failed to impress them cannot be blatantly cogent. Many of these differences are obviously of minor importance. A long list of such could be drawn up between any two species, the length of the list depending merely on the patience of the observer. Points such as variations in wood density, in habit, or in bark appearance can be readily paralleled in any large genus such as *Pinus*. It is not proposed to go over, *seriatim*, all the minor points listed by Buchholz. Reference here can be limited, and then as briefly as possible, to some of the features which he lists as of greatest generic significance and on which his distinction is essentially based.

(1) Buchholz emphasizes that the Sierra redwood requires two seasons to ripen the embryo and seed while the coast redwood requires only one. This, however, is merely another example of a widespread phenomenon in conifers. Forms closer to the basal type show frequently a longer cycle, derivatives and more advanced forms a shorter cycle; and this may be shown within the *family* or within the *genus*. Thus within the *family* Pinaceæ *Pinus* retains a longer, while *Pseudotsuga* shows the shorter cycle; but within each of the *genera*, *Podocarpus*, *Dacrydium* and *Araucaria*, as examples, the same phenomenon occurs.

(2) Difference in form of the cone scales in the two species is emphasized. But the difference is, in fact, slight. It is much less than exists between many species of *Pinus*. It is a great deal less than exists between, say, *Athrotaxis selaginoides* and *A. cupressoides*. These, however, are linked by *A. laxifolia*, the scales of which are nicely intermediate between the other two. If this species did not exist, a stronger claim could be made for the generic segregation of the first two on the basis of cone scale difference than can be made for the two Sequoias. It is of particular interest in this connexion to recall that Chandler[10], in a revision of *Sequoites Couttsiæ*, describes considerable variation in cone scale form. The same specimen may show thin imbricate scales, strongly peltate scales and many intergrades. Thus this well-known fossil type may show, in *one* specimen, greater differences in scale form than those which are claimed to be of *generic* importance in the living types. Further, even a small collection shows some variation in cone scale form in both the living redwoods. It is therefore worth while noting, in view of the great variability shown by *S. sempervirens* in its foliage, that it is not clear whether the slight difference in cone scale form is in fact constant over a wide range of types and habitat.

(3) The ovules and, later, the seeds are stated to be more numerous and in a double row in *S. gigantea*, but fewer and in a single row in *S. sempervirens*. But even Buchholz[1] himself states that this is not constant. He gives 3–7 as the ovule number in the latter species and 3–12 in the former. What then of forms with 5 or 6? A few minutes' dissection of young cones shows, in any event, that scales of *S. gigantea* with 5 or 6 ovules may show no doubling, while in scales of *S. sempervirens* with 6 or 7, some of the ovules are commonly out of place, forming an incomplete second row. Buchholz further gives the seed number as 2–5 in a single row for *S. sempervirens* and 3–9 in a double *or single* row for *S. gigantea*. It is difficult to see how a character which may show such wide variation and such a degree of overlapping can be used as a generic character.

(4) The foliage differences, including the leaf dimorphism of *S. sempervirens*, are emphasized. But it is surely common knowledge that much wider foliage differences are tolerated in other genera, *Podocarpus*, for example. If it be objected that the present *Podocarpus* should be split into a number of separate genera, must we then generically segregate *Araucaria Bidwillii* and *A. balansæ*? The foliage difference between these is wider than that between the Sequoias. And what of the junipers? Buchholz refers to the foliage of *S. gigantea* as "juniperoid". It is not clear, however, what is meant by that term as there are to be seen, in *Juniperus*, flat linear leaves with an abrupt peg-like base recalling the spruces, similar leaves with a green decurrent base, smaller acicular leaves close to the stem, closely adpressed cupressoid leaves and a whole series of intermediate types—the extremes much wider apart than in the Sequoias.

In regard to leaf dimorphism, it is again common knowledge that many conifer genera include species with only one leaf form and species showing leaf dimorphism of various types. This is well shown by the podocarps and araucarians. Thus *Araucaria Bidwillii* shows dimorphism, but the foliage of *A. araucana* is practically uniform. *Podocarpus* and *Dacrydium* both include species with only taxoid or only cupressoid foliage and species showing varying degrees of dimorphism. Thus *Dacrydium Kirkii* may carry, on the same branch, flat taxoid leaves up to $1\frac{1}{2}$ in. long and densely imbricate cupressoid leaves averaging only 1/10 in., and the transition is abrupt. Other species of *Dacrydium* are less spectacular, but these dimorphic types are not generically segregated *on that basis*; rather they help to link up the purely cupressoid and purely taxoid types. *Podocarpus dacrydioides* also bears cupressoid and taxoid foliage,

the two types grading somewhat. The taxoid type is essentially juvenile, but considerable foliage mixture occurs on older branches. Specimens may, however, retain completely the taxoid foliage for periods up to a hundred years, dependent on habitat and environment, so that full-grown coning examples of the same species in the same locality may appear very different and at least as distinct as the two Sequoias

The occurrence, in *S sempervirens*, of branchlets of a giganteoid type and the fact that some specimens, especially on freely coning branches, may carry almost as much giganteoid as taxoid foliage suggest, then, that the leaf dimorphism can be considered a linking rather than a separating character. This is not the place to survey fully the vegetative features of the coast redwood, but one further comment may be made. Possibly in relation to a polyploid instability it is one of the most variable of conifers. No *one* specimen can possibly be selected as the *type* It would need many herbarium sheets to illustrate the manifold variations which may quite commonly occur. It is then remarkable that Buchholz[1] lists as *typical characters of generic importance* features of the taxoid leaves which are *not* to be found in *any living* material here available and which are not recorded in any of the better-known descriptions and drawings. The leaves are said to be scythe-shaped and petioled with prominent midrib and revolute margins. If these features do occur on fresh material and were not described from dried specimens only, they cannot be characters of the type, but serve merely to extend the range of variability within the species

(5) The buds of *S sempervirens* are said to be scaly and those of *S. gigantea* naked. The meaning of the term 'scaly' is not quite clear, as it is obvious in winter that the dormant terminal apices of *S. sempervirens* are not covered with highly specialized bud-scales like a spruce or a fir. Anyone not familiar with the redwoods, however, could easily get the impression from this statement by Buchholz[1], and from others in the literature, that the 'buds' of *S. sempervirens* are rather specialized structures and quite different from those of *S. gigantea*, whereas, in fact, the basal structure of the apices of branchlets and twigs is essentially the same in both. As the commonly available accounts are rather inadequate, this point needs, unfortunately, more lengthy comment than the others.

A certain common plan of construction can be seen in many conifers—*Cryptomeria*, *Cunninghamia*, species of *Araucaria* and many others. Irrespective of the type of foliage, a number of the leaves at the end of a current twig in winter can be seen to be smaller, closely imbricate, and commonly of a modified and reduced form The most terminal, which may be slightly more modified though grading into those behind, cluster closely round and protect the dormant apical meristem and the young leaves of the next season already organized by it. These outer protecting leaves themselves grade into the inner protected ones; the whole is thus a simple bud. We have here just a cessation of growth with protection given by the last-formed modified leaves of the previous year. On resumption of extension growth in spring the group of small terminal leaves is left behind as a special zone at the base of the elongating twig, and these zones, scattered along the branches, indicate the sites of the winter rest. Their distinctness depends on the relative size of the adult leaves. In *Araucaria Bidwillii* longer zones of linear pectinate leaves alternate with the shorter clustered zones, while in *Cryptomeria* and many of the small-leaved species of *Araucaria*, in view of the more compact foliage, the sites of the winter rest are less obvious or even only to be found by close scrutiny In cupressoid forms the distinction scarcely exists.

The Sequoias show a similar plan and similar differences. The contrast between the zones of linear pectinate leaves and short imbricated ones is commonly very obvious in *S sempervirens*, whereas close scrutiny is needed to locate the sites of winter rest in *S. gigantea*. Incidentally, since the coast redwood shows such great vegetative variability there occur also, as might be expected, variations in bud organization. It would take a long descriptive account to explain adequately the nature of these and this is not the place to deal with them. Suffice it to say that such variations are slight or rare or mainly affect bud location *Typically*, however, the structure of the terminal apices is essentially similar in both Sequoias and quite in accordance with the plan outlined above, so that it cannot be said that one shows scaly buds, *in winter in the open*, and that the other does not. Of course, there may be differences, often marked differences (in detail), identity can scarcely be expected in two very distinct species. But often, as in the frequent case in *S sempervirens* of short lateral branchlets closely covered with densely imbricate reduced leaves, the structure of the apex, as well as the appearance of the whole branchlet, may be so strikingly similar to corresponding branchlets of *S. gigantea* that careless scrutiny could confuse small detached specimens.

The coast redwood, however, shows the peculiarity which has probably earned for it the reputation of having 'scaly' buds The terminal group of small modified leaves, left behind on the resumption of extension growth in spring, may gradually wither and become brown so that the base of each branch may be encircled with a cluster of thick brown leathery scales. A few points in connexion with this are of interest The withering and browning, in the first place, are gradual—a matter of weeks or months. In the second place, though common, they are not necessary or constant Examination of almost any specimen will show cases, often quite frequently, in which some or all of these modified terminal leaves remain permanently green. Further, the browning is not limited to the most terminal of these leaves, to those that cluster immediately round the resting meristem and which might be considered bud scales proper. Those back along the stem, for a distance which is usually short, but which may extend to as much as an inch, turn brown also It would appear that a certain number of the last-formed modified leaves of the previous growth, those fairly mature, exposed, and attached to a stem zone which will not elongate in spring, may turn brown. Those not matured in the previous growth, protected by the outer older ones, and attached to a stem zone which will show extension, expand as foliage leaves. Needless to say, the delimitation is not absolutely sharp, and many intermediate stages may be seen in spring.

Thus it is not a question of one type having 'scaly' buds and the other 'naked' buds. In both we are dealing with similar buds of a simple construction and of a relatively common type. The point is merely that in *S. sempervirens* a number of the terminal modified leaves of the previous growth may or may not turn brown in the course of the succeeding season. This unstable feature scarcely seems sufficiently weighty to necessitate a generic segregation, especially

as within *Juniperus*, *Podocarpus* and *Dacrydium*, in relation to their wide variation in foliage type, a much wider range of differences can be met with in the structure and behaviour of branch apices Anyone with access to a collection of junipers, to take one case, will find species with well-organized buds protected by definite and distinct bud-scales which may be deciduous, species with a later browning, like that of *S sempervirens*, species that behave like *Cryptomeria* or *Araucaria Bidwillii*, species with only a slight difference in foliage around the sites of dormancy, species showing a cupressoid habit with no distinct break between successive years' growth, and many intergrades. If the intergrading species disappeared and if *Juniperus* was now represented only by *J. oxycedrus* and *J. virginiana*, these, on the basis of leaf habit and bud type, would have a greater claim to generic segregation than the two Sequoias. Fortunately, however, the intergrades do exist

Clearly, one of the many phases of vegetative development shown in *Juniperus* is the organization of fairly specialized buds. To anticipate comment it may be mentioned that some of the *S sempervirens* variation types show a tendency in this direction, though this appears to be rare. Young shoots however, arising after felling, show the simpler type of bud.

(6) Buchholz[1] also states, and considers it important, that in the coast redwood the cone matures, browns and sheds seed within the year, while, in the Sierra redwood, the cone remains, for a number of years, green, attached to the tree and retaining its seeds. Actually the difference between them is less than would appear from this statement, there is a difference of degree only and not of kind. In *S. sempervirens*, at least under Irish conditions, the cones begin obvious growth from the bud in November, the matured cones shedding their seed late in December of the following year or even not until January of the next year still Thus from onset of growth to shedding of seed may take up to fifteen months, after which the cones remain attached to the tree for a further couple of years. In *S gigantea* visible growth from the bud begins in March, and the cones open to shed the seed any time after the third succeeding December, full maturing being thus spread over from 2¾ to about 4 years During this period they gradually darken and harden. But at any time after the maturing of the seed, late in the second autumn of growth for example, cones, brought indoors and kept dry and warm (60° F. or less), will open the scales and become brown within about ten days. Maturing cones of *S. sempervirens*, brought indoors about the same time while still dark green and closed, take, surprisingly, nearly as long to brown and open. The physiological difference between the two does not seem considerable. It would be of interest to relate the behaviour of the two redwoods to their very different ecological habitats and to determine, under natural conditions, the actual factors controlling the shedding of seed in relation to the age of the cone and the like It is suggested, however, that the important point in the cone behaviour of the two species is probably the ecological one of the longer seed retention by *S gigantea* and that the slowness of the changes in its cone advancing to maturity, changes which can be so hastened by drying, are physiologically related to this. Whatever its biological interest, however, the behaviour difference seems generically a minor point, comparable to the fact that, in many of the larger genera, the leaves may persist on the stem for greatly varying periods. But, even if the difference were more fundamental than it appears to be, the relatively longer retention of seed by *S. gigantea* is, in any case, paralleled elsewhere in the conifers and the point *not* given generic significance Such a retention is well known to be characteristic of many species of *Pinus* and is also seen in species of *Cupressus*, *C torulosa* shedding both seeds and cones at seed maturity while *C. macrocarpa* may retain the seed for years, its cones gradually darkening and hardening

In addition to these comments on six of the features most heavily emphasized by Buchholz[1], a few words are necessary on a very important consideration not referred to by him. If this generic segregation be made between the two living types, what then is to be done with the fossil nomenclature? What meaning in future must be given to *Sequoites*? Or must there be two fossil genera *Sequoites* and *Sequoiadendronites*? And how are the known fossils to be sorted between the two? Take, for example, the well-known *Sequoites Couttsiæ*. Its foliage, using the criteria of Buchholz, would bar it from *Sequoites*, and its cone, apparently, would bar it from *Sequoiadendronites*. Must we straight away found a new fossil genus for it? That way lies chaos. This again is scarcely the place for a survey of the relations between living and fossil Sequoias; but looking, without any special bias, at the fossil record as a whole, surely it is simplest, with our present knowledge, to take it as it appears to be, namely, the record of a widespread genus with a good range of form in foliage and cone, and it is surely simplest, for the present, to consider the two living redwoods as two surviving species, showing naturally certain marked differences, but differences within the gamut of the fossil range.

It is claimed, therefore, from this cursory survey, that against the background of intense human interest associated with the redwoods, there is no real evidence for a generic segregation. Ignoring the fossil record, as it does, the proposal appears based on the over-emphasis of points, long known to systematists and not of fundamental significance. The points of difference brought forward are either variable and intergrading or points which are definitely *not* given generic significance elsewhere in the conifers, even though shown in a more extreme condition If the segregation of the two Sequoias is admitted on this evidence, such criteria must be applied to the conifers in general, and then a wholesale splitting of other genera must straightaway be made. Such splitting would affect, for a beginning at least, *Araucaria*, *Dacrydium*, *Juniperus*, *Podocarpus*, *Pinus* and possibly *Abies*. The logical issue might be, at the last, the institution of a separate genus for each species even reasonably distinct from its fellows

Let us, then, leave those sentinels of the Sierras, the General Grant, the General Sherman, the Four Guardsmen, and the others, to stand watch in the centuries to come under a banner with the old familiar inscription—*Sequoia gigantea*.

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[2] Looby, W J., and Doyle, J, *Sci Proc Roy. Dub Soc*, **23**, 35 (1942).
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[4] Dayton, W. A, *Leaflets West Bot*, **3**, 209 (1943)
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[6] Lawson, A A, *Ann Bot*, **18**, 1 (1904)
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GEOLOGY OF THE PUNJAB SALT RANGE

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MY first contribution to the discussions on the age of the Saline series or Salt marls in the Salt Range, both in the Punjab and in the trans-Indus area in Kohat, was published in 1928[1]. Since then, several important papers on the subject have been published, by Messrs. D. N. Wadia, L M. Davies, G. de P. Cotter, E. R. Gee, and others. These have been very ably summarized by Dr. W. D. West in a paper entitled "Some Recent Advances in Indian Geology: The Geology of Salt Range"[2] In the meanwhile, Mr. E R Gee has completed his seven years careful and systematic mapping of the Punjab Salt Range and its continuation across the Indus into the North-West Frontier Province. He, in 1939, finally arrived at the conclusion that the Saline series or Salt marls occupy a stratigraphical position below the marine Lower Palæozoic strata and should be regarded as pre-Cambrian in age. Now quite recently Prof. Birbal Sahni and his co-workers in palæobotany at Lucknow have announced the discovery of abundant microfossils in the Salt marls[3].

In the above-mentioned contribution Prof. Sahni writes: "Fossils found in the Saline Series in recent years have repeatedly suggested that the beds are early Tertiary or even younger. But the value of the evidence has been questioned. . . In view of these objections, I collected . . . some lumps of rock-salt with intercalated thin laminæ of saline earth or 'kallar' from positions deep within the salt mines, with the view of examining the kallar for possible microfossils. . . . The investigation of this material has given results beyond all expectation: the bands of kallar must be teeming with signs of life; for every single piece has yielded microfossils. . . . The great majority are undeterminable as to genus and species, being mainly shreds of angiosperm wood, but there are also gymnosperm tracheids with large round bordered pits, and at least one good, winged, six-legged insect with compound eyes. These facts suffice to prove that the Salt Marl of the Punjab cannot possibly be Cambrian or pre-Cambrian as suggested among others by Dr. Murray Stuart, Sir Cyril Fox, and now also by Mr. E. R. Gee, until recently a strong advocate for the Eocene view. . . ."

No one has, nor will, question the importance of these discoveries now recorded by Prof. Sahni—the presence of abundant microfossils in the kallar or red saline clay, which is found associated with the rock salt in the cis-Indus mines, but appears to be absent or rare in the trans-Indus exposures. It is quite another matter where the interpretation of these facts is concerned, because the meaning of the term *in situ* needs explanation in relation to original sedimentary deposition, as will be discussed later. Dr. Sahni's communication conveys the impression that the microfossil assemblage is younger than Lower Tertiary (Eocene), the age which is usually ascribed to the Salt marl by those who have supported the idea that the Saline series is of Tertiary age. In view of Mr. Gee's mapping and the Lower Palæozoic to pre-Cambrian age which he has been obliged to admit, the question for the present must be how these Tertiary microfossils have found their way into beds which lie below those with a marine Cambrian fauna and are considered pre-Cambrian in age. It is to be remembered also that Mr Middlemiss was so struck with the unaltered condition, both dynamically and chemically, of these Lower Palæozoic formations in the Punjab Salt Range that he compared them with the pages of a volume fresh from the binders' hands.

Mr Middlemiss' original remarks are well worth reading[4]. Although so old, the original sandstones, shales and limestones remain as such and have not been converted into quartzites, slates or marble as is the case with equivalent strata in the Himalayas. Nor are these beds in the Punjab Salt Range found folded or even severely buckled in any widespread kind of way such as is common in regions of orographic mountains, as those in the trans-Indus area of the North-West Frontier. Beneath these unaltered Palæozoic strata lie the plastic and soluble deposits of rock-salt and saline marl (kallar) of the Saline series, and above the Palæozoic strata there are younger formations successively upwards to Lower and Middle and Upper Tertiary (see section given in Dr. W. D. West's summary[2]). In the exposures seen along the scarp of the Punjab Salt Range the salt marl are the most disturbed where, as might be expected, such plastic material is able to escape outwards from under the weight of overlying strata; and the overlying formations are seen to be tilted as though by block-faulting and, in places, have sunk into the marls (see ref. 1, plate 9). In other places there are evidences of subsidence by the actual solution of the salt, as occurred in Khewra village in 1925, when it was found that a spring of water was removing salt in solution at the same rate as organized mining was producing salt for the Government of India

At Pidh, on the Dandot plateau of Nummulitic limestones, the drainage is enclosed and sinks underground, and the water presumably carries some silt and such material in suspension with it. No details of the movements of such waters, or of the material they carry, have been made known; but there is very little doubt that such an investigation will yield interesting and perhaps surprising results, both as regards the salinity of the water and the material carried in suspension at different stages of its journey. Indeed, it is quite well known that pieces of wood and even the trunk of a tree (of a type now found growing on the hill slopes) have sunk down so-called 'swallow-holes', and are met with embedded in the solid rock-salt as though by movements akin to regelation. The kallar itself was thought, by Dr. W. A. K. Christie, Dr. Murray Stuart and myself, to represent the insoluble residue which is left when rock-salt has been dissolved and removed in solution[5]. Indeed, it is not uncommon to see 'pipes', which are filled-up sink-hole channels, down which water came but which were later choked up with transported solid residue or saline red clay very similar to kallar.

So long ago as 1878, when writing the official opinion of the geology of the Saline series, which were then regarded as probably Infra-Silurian (in the Murchisonian sense that the Silurian included the Cambrian), Dr. W. T. Blanford wrote as follows[6]:

"Owing to the softness of the marl, and to the tendency of harder rocks to slip upon it whenever it is sufficiently saturated with water, to destroy its coherence, and also to the salt beds being dissolved by water, the rocks of the Salt Range are broken and mixed up in a most complicated manner, masses of the marl having been squeezed by pressure in places into a position in which they appear to overlie more recent rocks, while all the newer formations are

cracked and faulted. The detailed geology of the range is consequently very intricate, and it is not always easy to tell whether dislocations of the strata are due to true faults traversing all the beds, inclusive of the salt marl, or whether the displacement is merely due to complicated landslips".

Dr. Blanford did not comment on the exceeding solubility of rock-salt (20,000 times that of limestone) or on the extreme plasticity of the saline marl, but these factors are thoroughly well known to-day, and will be appreciated by those who know the solvent effects of water on limestone—the various grottoes and caves, the removal of a bed of limestone beneath coal-bearing strata at Cherrapunji (Assam), the formation of bauxite (*terra rossa*) in the *dolinas* of Istria, etc.

Those who have a good knowledge of the probable depositional conditions—climates and land distribution—in the various geological epochs since Lower Palæozoic era in the Indian region are well aware that an arid period almost certainly prevailed when the Upper Vindhyans and their equivalents in the Salt Range—the Purple Sandstone—were laid down in early Cambrian or pre-Cambrian times, which, according to Mr. Gee, and those of us who have held the same opinion previously, was soon after the rock-salt deposits had formed in the Punjab area. These desert conditions and marine associations were widespread at that early epoch of the historical geology of India and adjoining countries to the west, so that there is nothing improbable about the geographical aspects of a pre-Cambrian to Cambrian age for the Punjab rock-salt occurrences. On the other hand, there is little such evidence in support of an Eocene age for these deposits, and my own special studies of the coalfields of Baluchistan, the North-West Frontier Province, Kashmir, the Punjab and Rajputana can find no epoch when marine and climatic conditions could favour the deposition of salt on a considerable and widespread scale Better possibilities may have existed in middle and upper Tertiary times, but so far as I know there has been no one who has claimed a younger age than Eocene for the rock-salt deposits of the Punjab or of the trans-Indus area. It is difficult to conceive of such conditions over the Salt Range area of the Punjab in middle Tertiary times and more so for such an upper Tertiary epoch, geographically at least.

The problem, therefore, seems to be to discover how the microfossils, found by Dr. Sahni and his co-workers in the Punjab Salt Range, have been carried into the Salt Marl or Saline series which are regarded as Cambrian to pre-Cambrian in age. Also, and this is a similar problem, how it is that Messrs. P. Evans and M A. Majeed were able to show that the heavy mineral residues, from samples of the Salt Marl, agreed most with the results obtained from Tertiary strata. I have not seen these results and do not know with what Tertiary strata the Saline series would be correlated on this kind of evidence. I have had the reliability of the heavy mineral assemblages tested by obtaining samples of sand from the Damodar—in its upper waters, at several places on its course through the coalfields and finally where it enters the Burdwan alluvial plains—and found that the proportions of certain heavy minerals were remarkably persistent This may thus suggest the idea that the streams flowing underground to the Salt marl may have carried heavy minerals down with them with the same persistency of proportions prevailing as those in the rocks from which the water derived its heavy minerals. There may thus be no evidence to prove that the Saline series are of the same age as the residues, from residues found in the rock-salt deposits. I suggest that the same argument applies to the microfossils. Incidentally, full details are not yet available of these microfossils, and a great deal more has to be done, such as a search for similar remains in the Tertiary strata of the Salt Range.

A small field committee consisting of Dr. H. Crookshank and Mr. E. R. Gee of the Geological Survey of India, with Dr. E. Lehner and also Messrs. E. S. Pinfold and J. Coates, geologists of the chief oil companies in India, are, at the time of writing (November 7, 1944), in the Salt Range to re-examine all the critical geological sections. They will no doubt give the subject of Dr. Sahni's microfossils and Mr. Evans's heavy mineral assemblages the most careful consideration [see p. 266 of this issue of *Nature*. Eds.] They are also unlikely to leave the question of the gypsum unattended to; but in this connexion I would say that the conversion of limestone into gypsum is not a remarkable phenomenon if the necessary conditions are favourable and a decomposable sulphide, such as pyrite, is available. The gypsum is, of course, a secondary product whatever might have been the age of the original materials involved—limestone and pyritiferous coal as an example. It is very likely, indeed to be expected, that a careful examination of the gypsum for microfossils and heavy minerals would provide evidence as to the age of the original substance, for example, limestone. It does not follow that this method of determination will fix the age of the strata in which the gypsum occurs, because the limestone (if so proved) might have been xenolithic For example, it may be in other strata than those belonging to the beds in which the limestone was deposited and in which it was originally truly *in situ*.

In contrast with the absence of tectonic folding in the strata above the Salt marl in the Punjab Salt Range, as around Khewra and Dandot, the beds associated with the rock-salt in the trans-Indus areas are characterized by folding Highly inclined beds with evidences of synclinal and anticlinal structures are common. Indeed the rock-salt occurrences appear to be normally found in faulted anticlinals in this Kohat region. It is just the position in which a plastic substance might be expected if it had been squeezed up from below by the dynamic forces of folding. The salt certainly appears to have been extruded upwards by great tectonic pressure, and shows evidence of this in its own texture. From a distance of only a few yards the rock-salt can often be mistaken for gneiss, as it possesses a gneissose structure, it is thus entirely different from the rock-salt in the Punjab, which appears to have escaped this degree of dynamic force. This is in general agreement with other observations. The trans-Indus region is closely involved in the orographic mountain ranges of the Indian borderland, while the Punjab Salt Range can scarcely be claimed to possess any orographic axis and is largely the southern scarp of a plateau region. It is for this reason that the supporters of a Tertiary age for the Salt marls have usually invoked an almost flat plane of sliding for the superincumbent strata. It is needless to say that over-thrusting for twenty miles or so in a region evidently devoid of serious folding has always been a mechanical defect in such explanations.

It must therefore be recognized that the two regions—the *cis*- and the *trans*-Indus—are orographically different, although one passes almost insensibly into the other. For this reason the rock-salt

has behaved differently under tectonic squeeze—which was very severe in the trans-Indus area and almost absent in the Punjab area. The salt deposits are probably of the same age—laid down in Cambrian and pre-Cambrian times. They were protected by overlying strata until comparatively recent times, when erosion in the Punjab area and dynamic folding in the Kohat region have disclosed these valuable deposits, which have been preserved for us since the Lower Palæozoic age. The treatment of the plastic salt in the folded strata will fully explain how it escaped upwards along a fault into an anticlinal; also how it was carried upwards or became entangled with newer strata—nummulitic limestone, oil shale or pyritiferous coal, and further, how when conditions and material were favourably disposed, gypsum has formed—from the included or xenolithic fragments in the rock-salt or adjacent to it in the strata from which the xenoliths were derived The *modus operandi* in the Punjab area was somewhat different; it consisted of subsidence by solution and transport by underground water whereby blocks of stone, tree stems and other derived material (such as micro-fossils and heavy minerals) have become embedded in the salt and in its insoluble residue (the kallar) in the Saline series of the Punjab areas. In neither case, however, *cis-* or *trans*-Indus, are these incorporated materials strictly *in situ*, and thus any gypsum formed from such derived material is, so to speak, truly *tertiary*, but in a *primary* setting.

In conclusion, I would like to quote a few lines from the last report submitted to the Government of India by Mr. H. B. Medlicott, director of the Geological Survey of India, before he retired in 1886[7]. He wrote:

"... The geologist's work is therefore sound and useful or false and misleading in proportion to his real acquaintance with the actuals and the principles of the exact sciences, and unless he reaches a certain standard of excellence his work is absolutely useless, or worse. In this respect the geologist is unique. A doctor may acquire a useful skill in the practice of medicine without being anything of a biologist: an engineer may do fair work with little or no knowledge of mechanics; a man may be a surveyor ... without any proper knowledge of geodesy or astronomy: because in all these businesses there are practical rules by which ordinary work can be safely executed. ... Geology is the opposite of all this: there is no operation called for. every act in its service is an independent judgment upon very complex inductive facts through an accurate knowledge of physical phenomena and their laws; if not scientific it is nonsense. Further it is to be noted that the data upon which the geologist has to frame his judgments are for the most part very scanty: from occasional scattered sections or single outcrops he has to attempt the representation of the rocks as they lie underground and their remote history. Thus, though based on the exact, it is itself the most inexact of sciences, and eminently demands conscientious and sober judgment. There is no science with which it is so easy to acquire a superficial acquaintance and to play the impostor. ..."

[1] See *Rec. Geol Surv. India*, **61**, Pt. 2 (1928), pp. 147–179, with plates 2–17 showing various views of plastic marls, tilted strata and subsidences
[2] *Current Sci*, **3**, No 9 (March 1935)
[3] *Nature*, **153**, 462 (1944).
[4] *Rec. Geol. Surv. India*, **24**, 19 (1891).
[5] *Rec. Geol. Surv. India*, **44** (1914), **50** (1919).
[6] "Manual of the Geology of India", Pt 2, Extra-Peninsular Area, p 487 (1878)
[7] *Rec. Geol. Surv India*, **20** (1887), Annual Report for 1886, p II.

SCIENCE IN PEACE

THE most striking characteristic of the open conference on "Science in Peace", organized by the Association of Scientific Workers at Caxton Hall, Westminster, on February 17 and 18, was neatly expressed by Prof J. D. Bernal in his final summing-up of the Conference The content of the fifteen papers submitted in three sessions devoted respectively to "Science and Production" (chairman, Prof. P. M. S. Blackett), "The Future Development of Science" (chairman, Sir Robert Watson-Watt) and "Science in Everyday Life" (chairman, Prof. H. Levy) had, he said, had the quite remarkable quality of having been 'orchestrated'. An account of the whole opus will accordingly be attempted here, not by separate discussion of the component movements, but by tracing the *leit-motiv* which recurred so clearly, inevitably and appropriately through all They are all familiar themes enough, but their interrelations took new emphasis, and their combined intellectual and emotional appeal was profound They were expansion, investigation, documentation, publication (the key theme in some expected and some less expected contexts), organization, integration, mechanization, standardization, nationalization.

The Conference opened appropriately with a paper on "The Future of British Economy", by G D N. Worswick, and closed equally appropriately with one on "The Place of Science in Culture", by Prof B. Farrington. The whole argument of the Conference was necessarily based on an expansionist economy providing full employment, the practicability of continuous full employment is in large measure governed by the full utilization of science, including the scientific control of processes, on the other hand, potentially revolutionary applications of science in industry are only acceptable to the workers if their justifiable fears about continuity of employment are categorically answered by a declared Government policy for assured and continuous full employment. The honouring of such an assurance depends on giving to the public interest its rightful place relative to private interest, and this in turn can only be assured by a substantial measure of Government control. No point made was more heartily applauded than the statement that bureaucracy is far more prominent and harmful in the larger aggregations of 'private' enterprise than in Government departments. Government control, varied and adapted to the needs of public interest in application to each main industry, must be control by the people acting through a democratic government in the interests of the people. The overall success of government control in the greatly expanded industry of the war effort was cited as an augury for the future.

The paper by Mr. Joe Scott, member of the Executive Committee of the Amalgamated Engineering Union, on "Science and the Productivity of Labour", emphasized the role of science in improving the conditions of life of the worker while at work and at leisure, in lightening labour and improving the use of leisure, in avoidance of injury and improvement of health. He stressed the inseparability of science from production; it was another of the recurrent themes of the Conference that we are no longer dealing with separable applications of science to industry; that we are now at a stage where scientific method should be inherent in every step of the industrial process, where the permeation of science through the whole of industry is a happily

irreversible process preventing the picking out of samples to be exhibited as 'science in industry'. This permeation of process demands a corresponding permeation of organization, in which the place of scientific work in the national economy is recognized and ensured by detailed interlacing in an industrial democracy, at all levels and in all significant groupings. An important element in this permeation is a much closer co-working with the trade unions, individually and collectively.

Mr. Scott introduced the two themes of investigation and documentation, with examples of welfare and health investigations, which could not have been carried through save by the machinery of the trade unions and shop stewards, and, from another angle, with a plea for direct availability to trade union negotiators of the scientific and technical facts which they require to support and answer statements made in negotiation.

This was one aspect of a universal demand for public availability of the facts—many already known privately, many not yet known even to managements in private enterprise—by which the efficiency and potential of any stage in the industrial process can be measured. The filling of the gaps in private and public information is essential to progress, and involves the large application of the methods of operational research within industries. There is need, indeed, not merely for organized research but also for research on organization; the appropriate structures for scientifically operated and publicly controlled industry are still in large measure unknown or ill-understood.

The demand for publication as a safeguard of the public interest was pressed at every session and thus in many different connexions. If it were necessary or desirable to condense in four words the essence of the discussion on "Science in Everyday Life", the words might well be "Publish and be Blessed". Full and free interchange of knowledge not only from scientific research, but also from studies on organization, not only on engineering efficiencies but also on economic efficiencies, 'all facts on the table' was regarded as essential to increased productivity, to improved conditions of life, and to the avoidance of diversions in favour of private interests.

"The Organisation and Finance of Science" were discussed by Dr. S. Lilley, who argued the case for the Association of Scientific Workers policy in favour of a national research and development council, responsible to the Lord President of the Council, for surveying national needs and resources and planning the broad lines of scientific work to meet the needs and develop the resources. The Council would plan the strategy of attack on these problems; it would neither execute the work in laboratories of its own nor interfere in the tactics of work in the laboratories, of existing types, to which it would allocate broad responsibilities and adequate finance. Expenditure at the rate of some twenty-four million pounds per annum, as compared with our pre-war seven million pounds per annum, it was stated, is required; a great expansion of laboratories would be needed; the research associations would be key factors in the plan, and no industry would be allowed to stifle co-operation by the withholding of financial contributions; the naive form of subsidy-without-supervision represented by tax remission on alleged research should not be permitted; publication of results would be insisted on. The new organization would require the participation of the representatives of the people in general, and of the scientific worker in particular, at all levels in the formation and execution of policy.

An important part of the problem of the deployment of our scientific forces is the striking of a balance between long-term fundamental work and short-term work of direct and immediate application. The chairman of the session on "The Future Development of Science" described the problem as one in the "intellectual economics of the social conscience"; Prof. Blackett emphasized the high long-term productivity of fundamental science, which must pass from its old state of self-determination towards an imposed orientation arising from increased direct support from public funds. This fundamental science must be guided by men of science, acting under broad directives on social objectives coming not from a bureaucratic Civil Service but from public opinion through Parliament and the Government answering to Parliament. An important part of this direction must rest on the economic policy adopted by the nation; there is virtually no limit to what science can do; there are limits set by economics on what it is worth doing, for example, in developing synthetics and substitutes as an alternative to importing. A short-term crisis, such as the present War, is the only exception to the law which forbids the sacrifice of the big future dividends offered by fundamental research to the smaller quick returns of too closely applied development.

Both Sir Robert Watson-Watt and Prof. Blackett directed attention to the need for a federation which could speak with the voice of the scientific practitioner at large; on a wider basis than the highly selective Royal Society and the highly specialized professional institutions; including the Association of Scientific Workers, with its vitally important trade union affiliation, but not excluding those who do not recognize that affiliation as necessary or desirable.

Prof. Bernal, in his contribution on the future development of "Applied Science and Technology", carried the development of the theme of 'organization' into the enunciation of the theme of 'integration'. The application of science is the practical side of the war against poverty and calls for the same spirit and intensity of organization as the current War. The revolution in the relations of science to industry is now far advanced; the essential now is the complete integration of science with industry; the dual problem is to make industry scientific through and through, and to make this possible by demonstrating to the public the need for this permeation and integration. The public has still far to go in appreciation of the need: it is still merely 'gadget-minded'.

This integration demands the full democratization of science in industry; democratization is far less advanced in industry than in politics. One necessary element, that of public criticism, is provided in the political sphere by Parliament; it could be provided in the sphere of industrial science by trade union organization. Only the scientific worker can determine the mode of application of science in industry; for this he must sit in the board room of management for the formation of policy, he must equally find his place in the joint production committee.

Integration, as was shown in those contributions to the first session which dealt with the basic industries of Britain, must be carried over the whole area of each industry and across the frontiers between industries; the separation of the generation of gas

from the generation of electric power and of both from the full utilization of coal is as artificial, irrational and wasteful as is the treatment of the coal industry as something apart from the chemical industry, of which coal is the very foundation.

Discussion on the coal industry was the most important single development of the mechanization theme, and it led to the conclusion, not from any devotion to nationalization as a good-in-itself, but from lessons in the long unhappy history of that industry in particular, that mechanization in coal-getting would not be attained without governmental control so firm and detailed as to mean nationalization. The inapplicability of any such simple prescription as 'American machinery everywhere' was recognized; but there was a clear conviction that a plan of mechanization measured to the geology and the degree of past working is of extreme importance

The discussions, which brought in variations on the theme of mechanization, interwove it so intimately with the theme of standardization that an answer to criticisms of 'dullness through standardization' was specially important. It was pointed out that general availability of the products of industry depends on the wide extension of mechanization, that mechanization can only be reasonably effective if the production runs are long runs giving large numbers of one pattern, and that consequently the total number of patterns available to the total field of consumption would be reduced. This does not, however, mean that the average consumer, with limited purchasing power, has a reduced range of available patterns. He would, in fact, have access to a wider range of better models, brought within his reach by the economies in cost attained through mechanization.

The Conference was made notable by the resumption of personal international contacts on a scale only now becoming possible as the war situation improves. The Sunday morning session was marked by the enthusiastic reception of addresses by Dr. Marcel Matthieu, a member of the executive committee of the French Association of Scientific Workers, and by Prof. A Danilov, chairman of the U S S R trade union covering scientific and ancillary workers in the laboratories of the universities, the academies of science and the research institutes. Prof Danilov was accompanied by four other Soviet colleagues ; it was noteworthy that the Soviet delegation to the World Trade Union Congress meeting in London included three scientific workers.

The Conference adopted at its closing session a resolution in the following terms .

"This public conference which has met to consider the tasks of science after the war, records its whole-hearted admiration of the fighting forces of the United Nations whose great achievements are bringing peace nearer at hand Their deeds are providing the foundations for a better world while the advance of science and technique are the tools with which it can be built. This conference declares its conviction that ·

(1) The achievement of a progressive rise in the standard of living of mankind needs the fullest use of science and technique within the frame-work of a world expansionist economy.

(2) An expansionist economy policy at home implies assistance to the backward and undeveloped countries to raise their productive level by the establishment of modern industry and scientific agriculture.

(3) In this country the advanced and efficient application of science requires democratic planning largely by scientists themselves. For this we propose a central research and development council under the authority of the Lord President of the Council.

(4) The problems facing the manual workers in the future, arising from the effect on their working conditions, of scientific and technical advances, demand close collaboration between the organized scientists and the rest of the Trade Union movement

(5) The closest collaboration must be achieved between the people of all nations, including the fullest interchange of scientific and technical knowledge based on the contacts now being built between the scientists in Great Britain and the Dominions, the U.S.S.R., France and the U.S A "

NEWS and VIEWS

Chemical Engineering at Cambridge

THE period extending between the two World Wars has been remarkable for the advances made in what is usually termed 'technology', and it is especially in chemical technology that this development has been most rapid and spectacular. A scientific discovery in a chemical research laboratory may be the progenitor of a finished manufactured article, but the aims and objects of the discoverer and those of the manufacturer are quite different. Since the manufacturer is interested in producing an effect, and since also economics plays an important part in his considerations, it is clear that many steps alien to a pure research laboratory have to be taken after a discovery has been made before a plant is in actual operation. We are confronted with the problem as to the most suitable training for such workers in chemical technology. Prof. Haber, who was at Cambridge at the end of the War of 1914–18, when asked what English chemical industry needed, replied that our weakness lay in not applying the methods of physical chemistry to industry. There is more than a germ of truth in this. Chemical engineering may be regarded by some as a misnomer for chemical technology ; and it is within the orbit of physics and chemistry rather than engineering that the new development should take place.

The larger industries in Britain can train their own men, but this is impossible in smaller units. The training given in the Technische Hochschulen on the Continent, or the Massachusetts Institute of Technology in the United States, has proved eminently successful in the respective countries. In Great Britain it appears that such further development as is required will take place in the universities. Hence the munificent gift of about half a million pounds by the Shell Group of oil companies to the University of Cambridge for the endowment of chemical engineering comes at an appropriate time The University, in accepting this, has likewise incurred a great responsibility. It is generally recognized that we have much leeway to make up to survive in the post-war world as an industrial nation. The chemical industries of Britain are by no means

the least important contributors to the country's wealth and may well become a dominant factor. Increased burdens will be placed on the nation's chemists and chemical engineers, and their training must be such that they can achieve the tasks that lie ahead. Care must be taken that the new Department is continually nourished by its roots—the subjects of chemistry, physics, mathematics and engineering, and those who pass through it should then build on sure foundations.

U.S. Research Board for National Security

ESTABLISHMENT of the Research Board for National Security by the U.S. National Academy of Sciences was announced on February 11 by Mr. Henry L. Stimson, U.S. Secretary of War, Mr. James Forrestal, U.S. Secretary of the Navy, and Dr Frank B. Jewett, president of the National Academy of Sciences. The Executive Committee of the new Board will be headed by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and the Board will consist of seventeen civilian men of science and nine representatives each from the army and navy, including Major-General Norman T. Kirk, Army Surgeon-General, and Vice-Admiral Ross T. McIntire, chief of the U.S. Navy Bureau of Medicine and Surgery. Civilian members include Mr. Herbert S. Gasser, director of the Rockefeller Institute for Medical Research, Prof. E. O. Lawrence, professor of physics at the University of California in Berkeley, and Prof. Isador I. Rabi, professor of physics at Columbia University. The Secretaries of War and Navy requested the president of the National Academy of Sciences under its congressional charter to establish the Board "to assist in providing for continued civilian participation in the longer-term scientific problems of national security when the Office of Scientific Research and Development proceeds to liquidate its activities as a temporary war-time agency. . . . The objective of the Board will be to continue, pending final consideration by Congress on creation of an independent agency, the close co-operation between civilian scientists and the armed services which has proven to be such a vital element in the prosecution of the war. Composed of high-ranking officers responsible for the needs and plans of the Army and Navy with an equal number of distinguished representatives of science, engineering, medicine and industry, this Board includes many of the features of the Office of Scientific Research and Development which has proven so successful as a war-time agency in mobilising civilian scientists and coordinating their work with the requirements and operations of the armed services. . . ." The announcement pointed out that "science is here broadly interpreted to include the employment of scientific method of analysis, experiments and tests in any branch of science or technology including engineering, medicine, psychology and biology."

Science and Planning

IN a memorandum "Science and the Real Freedoms" issued by the Association of Scientific Workers (price 3*d.*), Sir Robert Watson-Watt gives a very fair appraisal, under the title "Freedoms of Science", of the issue between planning and freedom, successfully avoiding the political prejudices with which the discussion is apt to become entangled. Sir Robert's article is based on a speech delivered in Manchester last October. He insists first on the necessity for clearly defining our terms. Science he regards as organized knowledge; but he considers that those constructive pursuits requiring for their prosecution, expansion and usefulness the application of a like process of thought are also properly covered by the term 'scientific'. The pure and applied sciences are in fact planned sciences. There is no human activity which is not a planned activity, and Sir Robert urged that we should consider whether organization in hope is not a nobler and more fruitful aspect of human endeavour than the organization of and through fear which has inspired our planning for war and even extended to the medical sciences. Asserting that the freedom to learn, to choose, to think, to work and to speak are the fundamental freedoms of the individual and the pillars of any tolerable society, Sir Robert urged that the real question is whether planning—which is inevitable—is to be open and public, or sectional, secret or selfish. He visualizes a structure in which the user who wants a definite result asks the research worker, the developer and the producer how best, by what particular kind of planning, he can attain his result, the research worker, the developer and the producer co-operate with the user, indicating to him the full possibilities. The greatest danger is over-simplification; but the planning of science in the application to national life is possible with no substantial risk to the freedom of fundamental science.

Education and Training for Engineers

IN a second report now issued by the Institution of Electrical Engineers, it is suggested that provision should be made for the education of craftsmen, technicians and professional engineers. There should be a three-year course for a craftsman certificate, followed by a more general course, lasting two years, in workshop administration. For the technicians group, the existing course for the ordinary national certificate in electrical and mechanical engineering should be co-ordinated as a basic course, and this should be followed, where necessary, by a course in advanced technology. Students who do well in the first two years of the ordinary certificate course should be combined with those who have reached the standard of a good school certificate in mathematics and physics, and these students should enter a two-year course leading to an intermediate national certificate designed to meet the requirements of the Section A examinations of the Institutions of Civil, Mechanical and Electrical Engineers. These courses would lead to the higher national certificates in electrical engineering and kindred subjects. Another section of the report contains proposals for the further education and training of electrical engineers returning from the Services.

University of Birmingham

THE Court of Governors of the University of Birmingham has nominated Mr. Anthony Eden for appointment as Chancellor of the University in succession to Lord Robert Cecil. The Pro-Chancellor (Mr. E. P. Beale) has announced that a public appeal for £1,000,000 will shortly be made to enable the University to proceed with urgently needed developments, especially the bringing together on one site of all the departments (some of which still remain in the centre of the city) and the building of additional halls of residence. Many of the donors to the appeal for £250,000 for rebuilding and re-equipping the Departments of Mechanical and Electrical Engineering have expressed the opinion that a great need of

the provincial universities is a fuller communal life for the students, such as can be secured by halls of residence.

Electric Discharge Lamps for Photography

MR. H. K. BOURNE presented a paper on this subject, illustrated by a comprehensive display of typical lamps, at a meeting of the Association for Scientific Photography on January 27. Photographically, electric discharge lamps have high actinic efficiency combined with low heating power, and they have a long life. Since the early days of the Cooper-Hewitt lamp, a glass tube several feet in length with a mercury pool at the end, development has proceeded along two divergent lines, low pressure and high pressure. In the modern low-pressure lamp, the pressure of mercury vapour is only a fraction of a millimetre; it emits considerable long- and short-wave ultra-violet radiation, which by means of fluorescent powders on the inside of the tube is converted to visible light of longer wave-lengths. It provides a well-diffused light-source closely resembling daylight and capable of giving accurate colour rendering. The high-pressure mercury vapour lamp consists of an inner glass tube containing the arc, sealed into an outer glass jacket. The arc tube pressure is about 1 atmosphere, and the arc is constricted into a narrow cord along the axis of the tube. The outer envelope is filled with an inert atmosphere. There is a wide range of types, the most powerful being in powers of the order of 10 kW. or higher, with a brightness ranging up to 100,000 candles per sq. cm. The spectrum is linear in character, and fluorescent powders cannot be used with the high brightness lamps; but with increasing pressure there is an improvement in the colour, the main lines broadening while the amount of continuous background increases. An amalgam of cadmium is sometimes used to improve colour. Brightness increases with increases of loading per unit length in the arc column, which has been made possible, first by the use of quartz tubes with molybdenum foil vacuum-tight seals, and later by the introduction of water-cooling, which dissipates approximately 70 per cent of the radiated heat. The author described a number of lamps including a compact source lamp with a maximum brightness of 18,000 c./sq. cm., a self-contained metal box-lamp which can be used without a lamphouse for the illumination of laboratory instruments, a 100-hour-life water-cooled high-pressure lamp with a luminous efficiency of 65 lumens per watt, a peak brightness of 30,000 c./sq. cm. and an internal pressure of about 75 atmospheres, and the B.T.H. syroposcopic tube which can give recurring flashes at a predetermined frequency or be employed as a synchronized flash-lamp for ordinary photography.

Resources of Ireland

IN celebration of the centenary of the publication of Sir Robert Kane's "Industrial Resources of Ireland", the Royal Dublin Society has published (price 2*s.* 6*d.*) a number of lectures delivered before the Society last August, under the general title of "The Natural Resources of Ireland". Prof. M. A. Hogan, in reviewing the fuel resources of the country, does not see much hope of increased coal production, but believes that resources of the limited coalfields are sufficient to last at least 250 years. He foresees, on the other hand, a great increase in the use of turf, provided that mechanized means of cutting it can be devised. This would entail the preliminary easy drainage of large areas of bog, in order to bear the weight of heavy cutting machines Mr. J. A. O'Riordan discusses the possibilities of water power. The Shannon and Liffey schemes have made a notable beginning, and their theoretical capacity is estimated at 84,000 horse-power. Gauging stations on other rivers and possibilities, still unmeasured, of smaller streams, promise great accretion to these resources. Mr. O'Riordan thinks that the potential production of hydro-electric power could eventually be doubled. It is to her water-power resources that Ireland must clearly look for energy in the future. A review of the mineral resources other than fuel, by Mr. D. W. Bishop, shows little of importance except phosphates The metallic mineral resources are very small. Some ores, in small supply, seem to have been exhausted.

Studies on Pollen Analysis

THE study of pollen has come much to the fore during recent years The pollen analysis of peat has become one of the most important techniques used in the study of post-glacial vegetation. Partly in view of the necessity of studying such geological data in terms of processes now in operation and partly in order to obtain information relating to plant allergens, research is now being directed toward fundamental problems relating to the liberation, dispersal and deposition of air-borne pollen. The results will have obvious implications in the field of floral biology and should also be of value to the meteorologist. The pollen of insect flowers is receiving attention as a means of determining the source of samples of honey. All the above studies have, up to the present, been referred to under the general heading of pollen analysis. The need for a better name has been expressed in *Pollen Analysis Circular*, a cyclostyled research bulletin edited by Prof. Paul B. Sears, of Oberlin College, Ohio. Messrs H. A. Hyde and D. A. Williams, of the National Museum of Wales and Llandough Hospital, Cardiff, respectively, in the October issue of that *Circular* suggest the term *palynology* (Gk. παλύνω (paluno), to strew or sprinkle; cf. πάλη (palē), fine meal; cognate with Latin *pollen*, flour, dust) for the study of pollen and other spores and their dispersal, and applications thereof. It is hoped that the sequence of consonants p-l-n (suggesting pollen, but with a difference) and the general euphony of the new word will commend it.

Motor Control-Gear

A PAPER read recently in London by D. Rudd before the Institution of Electrical Engineers reviews, in general terms, present-day practice in the design of industrial motor control-gear. The scope of the paper is limited to standard industrial equipment and the subject is approached from the user point of view. The first part reviews the principles on which modern design has been established, and the later sections discuss some of the factors that are likely to affect future development. The author states the case for the utmost simplicity in design and for greater latitude in the value of allowable starting-current peaks. Possible development in contact materials is discussed, and reference is made to the possibility of achieving some measure of standardization.

Veterinary Medical Institute

ACCORDING to the December issue of the *Anglo-Swedish Review* a new veterinary-medical institute has recently been inaugurated in the northern out-

skirts of Stockholm. One of the largest and most important departments is that for the production of horse serum. The stables with boxes for about eighty horses have been built with slanting lanternine roofs which let in the light above the boxes, and every box is provided with running water. Each of the horses produces about seven litres of blood, or raw serum, a week. Hot and cold air is supplied according to the season. In another and equally well-kept section are quarters for a large number of calves. The Institute comprises three sections: a pathological, a bacteriological and a serological section, which are supplemented by a mechanical and a parasitic laboratory. Altogether about 150 persons are employed. The new Institute provides increased facilities for effective combating of diseases of domestic animals, which still cause heavy losses.

American Birth-rate

ACCORDING to statistics of the Metropolitan Life Insurance Company (*J. Roy. Inst. Pub. Health and Hyg.*, Jan 1945), young mothers between the ages of twenty and thirty having their first child have been the principal contributors to the rapid war-time rise in the American birth-rate. The chief factor in the rise at these younger ages has been the increase in the marriage-rate, but a good part of the rise has been accounted for by women who had delayed having children until economic conditions were more favourable. Although the general birth-rate increased rapidly during the war period, the trend towards small American families as well is still in evidence, and families with five or more children continue to decrease.

Bright Light Sources

A PAPER read by J. N. Aldington on November 14 last before the Illuminating Engineering Society gave a general survey of tungsten filament projector lamps, showing the trend of recent developments in this field. The paper embraces consideration of the characteristics of tungsten filaments *in vacuo* and in gas-lamps employing both single-wound and double-wound helices, multi-filament lamps, and symmetrical light sources. Various types of lamps are illustrated photographically, and lamp performance data are given in tabular form.

Dried Starfish as Chicken Meal

IT is reported (*J. Amer. Vet. Med. Assoc.*, **55**, 151; 1944) that starfish, collected in the process of cleaning oyster beds, are now being dried and ground up to make chicken meal. An analysis of the meal showed that it contained 30·7 per cent protein, 17·6 per cent calcium and 0·35 per cent phosphorus. Tested against sardine fish meal of equal protein value, it proved its value as food; but its use had to be limited to 3·5–5 per cent of the total ration, because of the high proportion of calcium.

University of London

THE title of 'professor emeritus' in the University of London has been conferred on the following: Prof. R. H. A. Plimmer, who held the chair of chemistry at St. Thomas's Hospital Medical School during 1922–42; Sir Owen Richardson, who held the Wheatstone chair of physics at King's College during 1914–24 and the Yarrow Research professorship of the Royal Society attached to King's College during 1924–44; Dame Helen Gwynne-Vaughan, who held the chair of botany at Birkbeck College from 1921 until her retirement in 1944 and was a member of the Senate as a representative of the Faculty of Science during 1929–34; Prof Eva G. R. Taylor, who held the chair of geography at Birkbeck College from 1930 until her retirement in 1944.

Dr. C. W. Shoppee has been appointed to the University readership in chemistry tenable at the Royal Cancer Hospital (Free). Since 1939 he has been working at the Pharmaceutical Institute in the University of Basle.

The title of professor of mathematics in the University has been conferred on Dr. Paul Dienes, in respect of the post held by him at Birkbeck College.

Announcements

THE Medical Research Council has appointed Prof. A. A Miles, professor of bacteriology at University College Hospital Medical School, London, to the staff at the National Institute for Medical Research as from October 1, 1945, with the view of his becoming director of the Department of Biological Standards on the retirement of Sir Percival Hartley next year.

PROF. F. Y. HENDERSON, reader in timber technology in the University of London and assistant professor in timber technology in the Imperial College of Science and Technology, has been appointed director of Forest Products Research in the Department of Scientific and Industrial Research on the forthcoming retirement of Mr. W. A. Robertson, who has been director since 1933.

MR. V M. WADSWORTH has been appointed assistant lecturer in agricultural economics in the University of Leeds.

M. TURGUT EREM, the first educational attaché to be appointed to the Turkish Embassy in Great Britain, has arrived in London; he will act as inspector of Turkish students in Britain, of whom there are now about a hundred, including eighteen holders of scholarships awarded by the British Council, with which M. Erem will be in close touch.

THE Institution of Civil Engineers, with the Institution of Municipal and County Engineers, have appointed a joint committee to draw up notes for the use of engineers on the best location of underground services. The Committee will consist of Mr. W. H. Morgan, county engineer of Middlesex, as chairman, and ten other members; representatives of electricity and gas supplies and post office services have been nominated by or in consultation with the Institution of Electrical Engineers, the Institution of Gas Engineers and the chief engineer, G.P.O respectively. Communications should be addressed to the Secretary, Joint Committee, c/o Secretary, Institution of Civil Engineers, Great George Street, Westminster, London, S W.1.

THE following appointments have been made in the Colonial Service: C. F. Charter, to be soil chemist, Gold Coast; R. W. Crowther and D. A. W. Walker, to be veterinary officers, Nigeria; Miss M. E. Broughton, to be marketing officer, Nigeria; F. E. Luscombe, to be agricultural officer, Tanganyika; C. Harvey, senior agricultural officer, Fiji, to be director of agriculture, Fiji; E. W. Leach, senior agricultural officer, Nigeria, to be deputy director of agriculture, Trinidad; F. S. Collier, conservator of forests, Nigeria, to be deputy chief conservator of forests, Nigeria.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

'Sensitizing' by Protective Colloids

THIS is the name given[1] to the following phenomenon. It was observed[2] that the addition of a quite small amount of a hydrophile colloid to a sol of a hydrophobe colloid caused the latter to be coagulated (precipitated) by a much smaller amount (at much lower concentration) of a precipitating electrolyte than in total absence of the protective colloid. However, suitable larger amounts of the latter made necessary larger amounts of precipitating electrolyte than in the absence of the hydrophile colloid, hence the term 'protective colloid' for the latter.

In a letter in *Nature* in 1921[3] I suggested that many of the properties of the so-called (at that time) 'emulsoid colloids', and particularly of proteins, derived from a duplex character of their molecules in respect of their possessing both hydrophile polar and hydrophobe but organophile non-polar atom-groups The conception was developed more explicitly in a monograph on gelatin[4] to provide a basic *stratochemical* architecture for the micelles of proteins[5].

Experimental evidence was presented from the effect of gelatin on the interfacial tension between water and toluene and from the sorption of gelatin at this interface out of dilute solutions[6].

Recent investigations by me and my collaborators[7] have shown that the adsorption of many basic dyes to silver halides occurs in two stages. In the primary —and priming—stage, the dye molecules are deposited in a mono-layer, with the polar or ventral (to suggest an anatomical image) aspect of the molecule (ion) adhering to the silver halide surface, and the hydrophobe (or dorsal) edge projecting into the aqueous solution. After saturation is effected, a second mono-layer begins to build on. This does not form a rigid but a reversible layer, of the Langmuir type, because now the non-polar hydrophobe aspects of the dye molecules are attracted each to each between solution and primary adsorbate, while the polar, hydrophile groups of the secondary layer are attached to the water.

There are complications attendant on the formation of dimerized and polymerized aggregates of the dye molecules which need not detain us here. What is important is that we now have evidence from direct adsorption measurements from dilute solution, as well as from experiments on the coagulation and repeptization of silver halide sols by dilute gelatin solutions, that a quite similar process to that with dyes occurs in the adsorption of proteins to the silver halides and other little-soluble polar solids.

The electrophoretic and kindred investigations of H A. Abramson[8] and many others have led to the general conclusion that: "The fact that not only the isoelectric points but also the electric mobilities of quartz particles covered with serum albumin or egg albumin [or gelatin] are very nearly identical with the values of mobility for the respective dissolved protein indicates that practically all the polar groups of the protein molecules are available even after adsorption has occurred". The apparent paradox whereby the polar force fields of the protein should be quite free even when the molecules are at one and the same time most tenaciously and strongly adsorbed[9] to a polar surface is now explainable by our new observations, and the stratochemical layering. The electrical behaviour of the protein-coated silica particles, etc, is due not to the primary mono-layer, but to the secondary reversible layer.

It should be noted that the arrangement required (of polar-nonpolar alternance, or 'amphipathy', to use Hartley's term) seems consistent with Astbury's X-ray diffraction conclusion that "polar and non-polar side chains follow one another alternately along the main chains" in the protein structure[10].

The mechanism of 'sensitizing' evidently derives from the amphipathic character of the protective colloid, which is manifest not only in the proteins but also in such polyoses as the starches, dextrins, gums and pectins, and in kindred bodies, such as polyvinyl alcohol[11]. Some part of the initial precipitating effect of these hydrophile colloids can be replaced by an alternate electrolyte—and vice versa. In all cases, the primary monolayer furnishes lipoid surfaces, coherence of which is coagulation This is followed by repeptization by addition of further hydrophile colloid[7].

With my colleagues I shall deal with the subject more fully in subsequent publications.

S. E. SHEPPARD.

Chemistry Department,
Research Laboratories,
Eastman Kodak Company,
Rochester, N.Y.
Dec. 19.

[1] Freundlich, H., "Kapillarchemie" (Aufl 2, Leipzig, 1922), 799 *et seq.* Also for non-colloidal non-electrolytes, *idem*, 636 *et seq*

[2] Henri, V., *et al*, *C R Acad Sci*, **55**, 1671 (1903).

[3] Sheppard, S. E., *Nature*, **107**, 73 (1921).

[4] Sheppard, S. E., "Gelatin in Photography". I Monographs on the Theory of Photography, No 3 (New York. D Van Nostrand Company, 1923), 188

[5] cf. also *Ind and Eng Chem*, **13**, 37 (1921)

[6] Sheppard, S E, and Sweet, S S, *J Amer. Chem Soc*, **44**, 2797 (1922).

[7] Sheppard, S. E, *Atti X Congress Internat di Chim*, VI, 234 (1938); also Sheppard, S E, Lambert, R. H, and Walker, R D, *J Chem. Phys*, **7**, 265 (1939)

[8] Abramson, H A, "Electrokinetic Phenomena" (Amer. Chem Soc Monog), 1934

[9] cf. Sheppard, S E, Lambert, R. H., and Keenan, R. L, *J. Amer Chem Soc.*, **36**, 174 (1932)

[10] Astbury, W, *J. Chem Soc*, 337 (1942).

[11] cf. Sheppard, S E, and Newsome, P T, *J Chem Phys.*, also Pt 2 (in the press. *ibid*)

Age of the Saline Series in the Punjab Salt Range

PROF. B. SAHNI's important observations[1] have necessitated a reconsideration of this problem. In order to review the geological evidence on the ground, an excursion was arranged to examine several sections which had led E. R. Gee, of the Geological Survey of India, and other geologists to the conclusion that the Saline Series of the Salt Range is of Cambrian or pre-Cambrian age. Prof Sahni was unfortunately unable to take part in the excursion, the party consisting of the undersigned.

The sections visited were near Khewra in the eastern part of the range, and in the Warcha-Sakesar area of the middle western portion. This examination showed that an Eocene or later age for the Saline Series is irreconcilable with the field evidence, which, in our opinion, indicates that this series is Cambrian or older.

The junction of the Saline Series and the overlying Purple Sandstones (Cambrian or older) is in several sections conformable and transitional. This is well seen in exposures east of the Warcha Circuit House

The junction of the Upper Carboniferous Talchir Boulder Bed with various stages of the Cambrian and the Saline Series was examined over several miles of its outcrop south of Sakesar. Here also our opinion is that this junction is normally an ordinary sedimentary overlap, thus precluding an age for the Saline Series later than Talchir

Regarding the evidence of Tertiary to sub-recent fossils found by Prof. Sahni, we observed so many instances, even deep in the salt mines, of sub-recent material being enveloped in the salt and in the marls, that it seems possible Prof. Sahni's fossils had a similar origin, notwithstanding that in many cases they have every appearance of being *in situ*. Our conclusions were arrived at despite the recognition of certain difficulties, such as the occurrence of minute plant fragments of post-Cambrian age in the dolomites and oil shales, for which at present we have no clear explanation to offer.

The Foraminifera, formerly believed to indicate an Eocene age for the Saline Series[2], were later proved to be derived material embodied in outcrops as a result of subsequent movements.

J. Coates. P. K. Ghosh.
H. Crookshank. E. Lehner.
E. R. Gee. E. S. Pinfold.
Warcha.
Nov. 10.

[1] Sahni, B, *Nature*, **153**, 462 (1944)
[2] Davies, L M, *Nature*, **154**, 53 (1944)

Synergistic Effect of Cod Liver Vitamin D on Synthetic Vitamin D_3

Although the average vitamin D content of cod liver oil of authentic origin as produced by the world's fisheries in normal peace-time lies in the neighbourhood of 85 international units per gram, there are very wide limits of variation according to the season, condition of the fish in relation to spawning and the actual fishing ground on which the fish are caught. In our experience these natural variations cover a range from below 50 to above 500 international units per gram.

Experience with authentic cod liver oils shows that when oils of widely differing vitamin D potency are blended, the vitamin D content of the blend is in harmony with the calculated figure derived from the individual potencies of the components of the blend. This would be agreed as a matter of common experience.

On the other hand, we find that when synthetic vitamin D_3 is blended with cod liver oil, the assay in international units is higher than the calculated figure. Two typical results of tests using eighteen pairs of rats in each biological assay are given below:

Vitamin D content of the cod liver oil (I.U/gm)	Amount of synthetic vitamin D_3 added to 1 gm. of cod liver oil (I.U)	Calculated vitamin D potency of the resulting mixture (I U./gm.)	Actual vitamin D potency of the resulting mixture (I U/gm)
90	80	170	206
84	81	165	245
89*	67	156	227

* Average figures for a comprehensive series of thirteen similar blends, using eighteen pairs of rats for each assay.

It is not the purpose of this letter to offer any final explanation of the apparent synergism between the vitamin D of cod liver oil and synthetic vitamin D_3. It is known, however, that the vitamin D of cod liver oil, often presumed to be a single substance, is really a complex. Bills[1] and other workers have shown that there are at least seven forms of vitamin D. Hickman and Gray[2] have demonstrated by short-path distillation the possibility of there being at least six different substances in cod liver oil with antirachitic properties On the other hand, the known synthetic forms of vitamin D are apparently individual substances which can, in fact, be crystallized in the pure state.

If the full activity of vitamin D as a therapeutic substance used to cure experimental rickets in rats depends on the simultaneous presence of more than one component, then vitamin D_3 itself, by reason of its singleness of nature, would not exert its full curative action until one or more of the other essential components of the vitamin D complex are adequately represented in the blend.

These observations have very wide implications, especially in view of the different efficiencies for rats and chickens respectively of vitamin D_2 and various fish liver oils. In any event, vitamin D_3 can apparently become much more effective for rats if the vitamin D complex of cod liver oil is fed simultaneously to the experimental animals. It is a matter for further investigation as to whether the synergism of the type described between the vitamin D of cod liver oil and vitamin D_3 is general, or whether it is confined to the specific case of experimental rickets in rats.

W. Stott.
Cyril C. Harris.
Biological Testing Station,
British Cod Liver Oil Producers (Hull), Ltd.,
Hull. Jan. 15.

[1] Cold Spring Harbor Symposia on Quantitative Biology, **3**, 328 (1935)
[2] *Ind Eng Chem*, **30**, 796 (1938)

Diabetogenic Action of Alloxan Derivatives

The finding of Shaw-Dunn and co-workers[1] that alloxan (and a styryl-quinoline) causes diabetes by damaging the pancreatic islet cells has since been amply confirmed in a number of laboratories, working with various animal species. Attempts to discover other substances with similar action have so far been unsuccessful, nor has any explanation been offered regarding the mechanism by which alloxan attacks the β-islet cells

During an investigation of this question, a number of substances, all closely related to alloxan, were found to produce diabetes in rats when injected intravenously. These substances were: methylalloxan, alloxantin, dimethylalloxantin, dialuric acid, methyldialuric acid. Dimethylalloxan and dimethyldialuric acid (as sodium salt) were found to be highly toxic, the initial symptoms suggesting vagus stimulation, and did not cause diabetes in doses up to 100 mgm. per kgm. body-weight of rat. Renal damage, as judged by albuminuria and uræmia, which was more or less evident with all these compounds including alloxan, was particularly pronounced with dimethylalloxan. Other disubstituted alloxans are now under investigation.

Diabetogenic action was not caused by tartronic acid, dimethylalloxanic acid (in which the fissure of

the pyrimidine ring caused disappearance of the toxicity), alloxanic acid, violuric acid and murexide, the last three compounds having already been proved non-diabetogenic by several authors[2,3,4].

It is of interest that the minimum effective diabetogenic dose is about the same with all these compounds, including alloxan, namely, 50–70 mgm. per kgm. body-weight. This dose resulted in the development of extreme hyperglycæmia, glucosuria, polyuria and occasional ketonuria within 12–24 hours. These findings may indicate a very rapid conversion of alloxan to dialuric acid or vice versa, and an equally rapid decomposition of alloxantin. Alternatively, all these compounds might have some property in common, which enables them to interfere with processes within the pancreatic islet cells.

One of the best-known properties of alloxan and some of its derivatives is the decarboxylation and desamination of amino-acids, discovered by Strecker[5] in 1862. We have examined some other substances which give the Strecker reaction. Ninhydrin, which is very toxic, did not produce diabetes in rats, nor did isatin, which is very sparingly soluble.

All the above diabetogenic substances were found to react *in vitro* with hæmoglobin The alloxans were methæmoglobin formers, while the alloxantins and dialuric acids rapidly converted oxyhæmoglobin into reduced hæmoglobin and blackish-green decomposition products, probably bilirubinoid in nature. The latter effect was also observed *in vivo* with some of the dialuric acids. The alloxans, on the other hand, when given in normal dosage, failed to induce noticeable methæmoglobin formation in rats.

In conclusion, it may be mentioned that Jacobs[2] and Goldner and Gomori[3] have reported negative results in attempts to produce diabetes with alloxantin and dialuric acid, using rabbits and dogs respectively. With a dosage of 150 mgm. (supersaturated solution) dialuric acid per kgm. we have, however, obtained diabetes in a rabbit after intravenous injection.

G. BRÜCKMANN.
E. WERTHEIMER.

Pharmacology Section,
The Hebrew University and Hadassah,
Jerusalem. Dec. 26.

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Liberation of H^+, Al^{+++} and Fe^{+++} Ions from Hydrogen Clays by Neutral Salts

THE interaction between hydrogen clays and neutral salts gives rise to H^+ and Al^{+++} and, in a secondary measure, Fe^{+++} ions in the salt extracts. The mechanism of this reaction has been the subject of much discussion[1-8]. Some investigators[1-5] consider that the acid liberated by the salt dissolves Al^{+++} and Fe^{+++} ions from the sesquioxides present in the hydrogen clay, while others[6-8] postulate a direct exchange of Al^{+++} and Fe^{+++} ions for the cations of the added salt.

A number of publications[9-12] from this Laboratory have dealt with the liberation of Al^{+++} ions from hydrogen clays isolated from Indian soils by various neutral salts. At a constant pH the amounts of displaced Al^{+++} ions (A) have been found to increase with the concentration (C) of the added salt. The plot of A against C has the shape of the usual adsorption isotherm. At a given equilibrium pH, barium chloride liberates a much larger quantity of Al^{+++} than hydrochloric acid. All these observations indicate a direct exchange of Al^{+++} ions for the cation of the salt, instead of their liberation by a secondary dissolution process. A direct exchange of both H^+ and Al^{+++} has been observed. At low values of C, very few Al^{+++} ions and mainly H^+ ions are exchanged. With an increase in C, the amounts of both displaced H^+ and Al^{+++} ions increase, but that of the latter at a relatively greater rate than the former. A relation has been found between A and the base-exchange capacity (B), calculated at the inflexion points in the titration curves with sodium hydroxide, of subfractions of hydrogen clay isolated from the same entire clay fraction. Both A and B usually increase with diminishing particle size. Any deviation from this regular variation in A with the particle size is also reflected in similar deviations in the case of B [13]. Depending on the nature of the hydrogen clay, an increase as well as a decrease in A accompanied by similar variations in B have been observed on the removal of free inorganic oxides present in the hydrogen clays according to the method of Truog *et al.*[14]. The decrease in A and B probably indicates a decomposition of the absorption complex.

The amounts of H^+, Al^{+++} and Fe^{+++} displaced from hydrogen clays Satara-F and Jorhat-F prepared respectively from a black cotton and an acid soil decreased to almost negligible values on continued leaching with a normal solution of barium chloride. But the above cations were liberated, as often the barium clay thus obtained was rendered desaturated by treatment with $0 \cdot 02\,N$ hydrochloric acid and then leached with a solution of N barium chloride. Much smaller quantities of the cations were displaced from the desaturated clays compared with the original hydrogen clays. In the case of the hydrogen clay Satara-F, which contains the clay mineral montmorillonite, judged from X-ray studies[15], and certain viscous[16] and electrochemical criteria[17,18], the total amount of acid in its 'leachates' decreased progressively with successive desaturations. With the hydrogen clay Jorhat-F, containing mainly kaolinite and a very small quantity of montmorillonite, it tended to a constant value. The amount of Al^{+++} ions displaced from Satara-F decreased up to the fifth desaturation and then increased. In the case of Jorhat-F it decreased up to the fifth desaturation and then became constant. Very little ($0 \cdot 5$ to $0 \cdot 4$ milli-equivalents per 100 gm. of oven-dry hydrogen clay) Fe^{+++} ion was displaced by N barium chloride from the two hydrogen clays. But with Satara-F its amount increased with successive desaturations up to the fifth one and then began to decrease In the case of Jorhat-F it remained practically constant. The sum of the amounts of displaced Al^{+++} and Fe^{+++} ions decreased with progressive desaturations, tending to a constant value with both the hydrogen clays. After the full cycle of operations (eight desaturations in the case of Satara-F and six with Jorhat-F) a marked reduction[19] in base exchange capacity (B) of Satara-F was observed. Jorhat-F showed no material change[19]. The observed reduction in B indicates a decomposition of Satara-F. X-ray diagrams obtained by Mr. S. N. Bagchi[15] gave no lines characteristic of montmorillon-

ite in the hydrogen clays at the end of the above cycle of operations. A relation between the mineralogical composition of the clay and the quantities of displaced Al^{+++} and Fe^{+++} ions is indicated by the above results. Further work with pure clay minerals is in progress.

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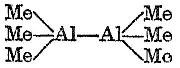
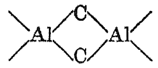
Structure of Aluminium Trimethyl

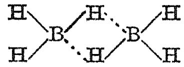
THE existence of the dimer aluminium trimethyl has aroused considerable interest. Electron diffraction determinations[1,2] are in satisfactory agreement with an ethane structure (I). However, this structure is for many reasons most unlikely: (1) it should differ from the bridge structures of the related aluminium halides[3] Al_2X_6, aluminium dimethylhalides[2] $Al_2Me_4X_2$, as well as of the boron and probably aluminium hydrides[4]; (2) it cannot be accounted for by any existing valence theory; no forces are available for joining the two $AlMe_3$ molecules; (3) it requires a shorter interatomic distance (about 2·20 A.) between the equally charged Al atoms than that of a covalent Al–Al linkage (> 2·48 A.); (4) the unstability (non-existence) of a dimer boron trimethyl cannot be explained.



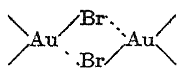
I



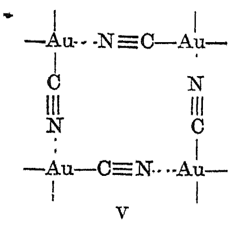
II



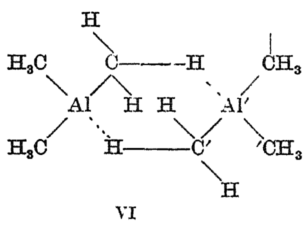
III



IV



V



VI

Raman spectra favour a bridge structure[5], but that of type II is excluded by the results of electron diffraction determinations[2]. As shown elsewhere[6], the stability of B_2H_6 and Al_2H_6 can be accounted for on the basis of the bridge structure[4] by the formation of B . . . H hydrogen bonds (of an essentially electrostatic nature) (III). This also allows a bridge structure for Al_2Me_6, which has not yet been considered (VI). A six-membered ring is formed by Al . . . H hydrogen bonds. Owing to the inductive electron transfer from the positive Al atom, the negative charge on the H atom should be appreciable. The non-existence of B_2Me_6 can be explained by the much smaller electron transfer from the less-positive B atom, which is not compensated by the expected shorter interatomic distance. Al_2Me_6 is now no exception to the bridge structures of its related aluminium and boron derivatives. This is comparable to the dimer gold dialkyl halides and tetramer cyanides[7], where one atom (halogen) (IV) and two atoms (C≡N) (V) respectively form the bridge. No new valence theory is required, and the Al–Al distance is now longer than that of a covalent linkage.

It is noteworthy that the distances to be expected for structure VI are in qualitative agreement with the peaks of radial distribution curves derived from electron diffraction determinations, which are 2·07, 2·6, 3·42, 3·93[1] and 2·01, 2·58, 3·3, 4·05 A. respectively[2]. The C–H and Al–C distances within the six-membered ring will be near 1·09 and 2·01 A. respectively, the Al . . . H distance slightly longer than that of a covalent linkage and not very different from (1·7) 1·8 A. Making the reasonable assumption that the angles CAlH and AlCH in the ring are about 109·5°, the important distances mainly contributing to the radial distribution curve below 4 A. are Al–C 2 01 A., Al–C′ 2·73 A., Al–H 2·59 A., Al–Al′ 3·22 A., C–C 3·28 A., C–C′ (both in ring) 3·5 A., C (in ring)–C′ (outside ring) 4·0 A. These distances show a reasonable relationship to the observed peaks. This should justify new quantitative calculations, based on the suggested bridge structure, for testing such models and possibly establishing its actual dimensions.

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Mechanism of the Red Cell Changes in Non-hæmolytic Jaundice

CERTAIN characteristic changes are found in the erythrocytes in obstructive jaundice. The red cells are increased in diameter but not in thickness, so that they are relatively flat cells. Associated with this alteration in shape, target cells are seen in the blood in large numbers and the red cells are resistant to hæmolysis by hypotonic saline solutions. The volume of the cells may or may not be increased.

The same changes have been demonstrated in cases of toxic-infective jaundice. Here, in most

instances, the presence of some obstruction to the outflow of bile is indicated by the clinical features of dark urine and pale stools and a positive van den Bergh test in the serum.

It has been shown that the changes in the erythrocytes occur as the result of alterations in cells that are already circulating in the blood at the onset of the jaundice, and not because of altered erythropoiesis.

The changes in the red cells may be present to a marked degree as early as ten days after the onset of the jaundice. The possibility of this being the result of a new generation of cells is precluded by the fact that erythropoiesis would have to proceed at about ten times the normal rate, and yet no increase in the reticulocytes is seen Likewise, in recovering cases the blood is restored to normal in as little as ten days, again without signs of rapid cell regeneration.

If red cells are transfused into a jaundiced patient, the transfused cells can be shown to take on the characters described above in about a week. Some mechanism, therefore, exists for producing these changes in circulating red cells.

The bone marrow in jaundice shows no abnormality that could be responsible for the alterations found in the circulating cells.

Detailed analysis of the changes in the chemical constitution of the blood in non-hæmolytic jaundice shows that none of these alterations is responsible for the changes in the red cells

It is suggested by comparison with the red-cell changes found after splenectomy that the changes in the erythrocytes in jaundice of the non-hæmolytic variety are due to functional disturbance in the circulation of the spleen in jaundice

Changes in circulating erythrocytes in the direction of roundness in cases of hæmolytic anæmia have received much prominence in recent years. It is suggested here that the opposite change, flattening, also results from alterations in cells as they circulate in the peripheral blood stream.

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Siderocyte Levels in 'Normal' Human Beings

FOLLOWING the partial elucidation of the physiological properties of the siderocyte as the normal ageing erythrocyte[1] and in view of pathological studies now in progress, it became desirable to establish 'normal' siderocyte levels in human beings, and to study the effects of sex, age, menstrual cycle, diurnal variation, iron therapy and exercise upon such levels.

Below are summarized the results of such an investigation carried out in the University of Birmingham.

The differences of the means between the age-groups in the female do not at any point attain statistical significance, but the first and last age-groups in the male do attain a significant difference of mean from their neighbouring groups. The difference between the means for the male and female is also significant. Both series, grouped in 0·1 per cent siderocyte-class intervals, approximate fairly well to 'normal' distributions.

Daily siderocyte counts throughout two successive menstrual cycles in each of two female subjects showed no cyclical tendency. Hourly siderocyte counts on six subjects revealed no evidence of diurnal variation The exhibition of fairly large doses of ferrous sulphate (up to 1,500 mgm iron daily) for periods up to 21 days did not affect siderocyte levels in four subjects.

AN ANALYSIS OF SIDEROCYTE LEVELS IN 279 'NORMALS' BETWEEN THE AGES OF 5 AND 65 YEARS

Total series

Age group	5–	15–	25–	35–	45–	55–65	All ages
Number of subjects	32	118	46	30	29	24	279
Mean (%)	0·37	0·52	0·48	0·56	0·52	0·48	0·50
S D	0·29	0·24	0·29	0·23	0·25	0·15	0·25
Coefficient of variation	77%	47%	62%	41%	48%	31%	50%

Male series.

Age group	5–	15–	25–	35–	45–	55–65	All ages
Number of subjects	16	68	24	17	17	12	154
Mean (%)	0·32	0·50	0·41	0·53	0·51	0·40	0·46
S D	0·15	0·23	0·27	0·19	0·28	0·15	0·23
Coefficient of variation	48%	45%	66%	36%	57%	37%	50%
P for diff of successive means		0·01	0·15	0·15	0·8	0·001	

Female series

Age group	5–	15–	25–	35–	45–	55–65	All ages
Number of subjects	16	50	22	13	12	12	125
Mean (%)	0·43	0·55	0·55	0·59	0·55	0·57	0·54
S.D	0·29	0·26	0·31	0·25	0·21	0·10	0·27
Coefficient of variation	77%	48%	57%	46%	37%	17%	50%
P for diff. of successive means		0·15	0·9	0·65	0·65	0·8	

Grand mean Male 0·46 ; Female 0·54 , Difference 0·08 $P = 0·01$

Moderately severe exercise (sprinting 440 yards) produced no change in level immediately afterwards in each of four subjects, but the injection of small doses of adrenalin, which is without effect on blood *in vitro*, produced an immediate but transient rise of up to 2 per cent, falling to normal in 1½ hours, in six subjects In our view, this response is probably due to splenic contraction, since Granick[2] has shown numerous siderocytes in teased spleen preparations.

Siderocytes are thus shown to be normal and constant inhabitants of circulating peripheral blood in normal human beings, there being a slight sex difference in level. For most practical purposes, however, a value of 0·5 ± 0·3 per cent will serve as the 'normal' level for human beings above the age of five years. Higher levels have been reported in infants[3], but so far no information is available as to when the level becomes stabilized.

Exercise, iron therapy, and menstruation do not appear to influence the siderocyte levels herein established, nor do they show diurnal variation

Full details of this investigation will be published elsewhere.

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Structure and Nutrition of the Cornea, Cartilage and Wharton's Jelly

WE have read with great interest the letter by Barcroft *et al.*[1] Barcroft and his co-workers observed the passage of large molecules in Wharton's jelly of the umbilical cord of fœtal sheep, and they believe that there exists a non-vascular pathway through which nourishment travels along from the placenta towards the fœtus While there seems to be every justification for this interpretation of the findings, we are of the opinion that this easy and relatively fast passage of large molecules may contribute to the nutrition of Wharton's jelly itself. With a few exceptions[2] (apart from the large umbilical vessels, which are not supposed to give off nourishment for the surrounding tissues) the substance of the umbilical cord is completely avascular. In this respect Wharton's jelly is closely similar to cartilage and the cornea It is generally accepted that both cartilage and the cornea are nourished by diffusion from the surrounding tissues, and it seems to us that to assume a similar method of nourishment for Wharton's jelly is entirely justifiable Both Wharton's jelly and cartilage are rich in two closely related substances, mucoitin sulphuric acid and chondroitin sulphuric acid respectively.

Some months ago our attention was directed to the work of Jorpes *et al.*[3] describing the presence of heparin in the substantia propria of the human and bovine cornea This observation was based on the metachromatic staining reaction of the substantia propria corneæ after toluidin-blue staining. We repeated this method on sections of rabbit, guinea pig, rat and normal human corneæ, and we confirmed the presence of a metachromatic substance. The reaction in the rabbit's cornea, especially after the use of basic lead acetate as a fixing agent, was particularly intense This staining reaction is strictly confined to the cornea and stops sharply at the corneo-scleral junction. While the real chemical basis of this reaction can be proved only by micro-chemical analysis, it appears justifiable to suppose that the substance responsible for the specific staining reaction is either heparin, which is a mucoitin poly-sulphuric acid, or a chemically allied substance, because only these substances give a metachromatic staining reaction with toluidin-blue.

The presence of metachromatic substances in the substantia propria corneæ is not given in standard histological descriptions, although muco-protein was found by Morner[4] and mucoitin sulphuric acid by Levene[5] after chemical analysis. Krause[6] in his book on the biochemistry of the eye, referring to the above findings, states that the part played by these acids in such "metabolically inactive" tissue as the substantia propria is not known.

It is of interest that the mast cells, which, according to Jorpes *et al.*[3] are responsible for the production and the maintenance of the heparin level of the circulation, give a particularly vigorous metachromatic staining, and consequently the intensity of metachromasia displayed by these chemically related substances can be used within certain limits as a starting point for chemical differentiation.

As previously stated, the cornea derives its main nutrition by diffusion from the margin. We have found numerous mast cells around the capillary loops at the limbus corneæ, and we believe that these cells facilitate diffusion and nutrition by maintaining a high heparin concentration. The translucency of the cornea may also be maintained by and dependent upon the presence of heparin, or some chemically related substance

The cornea, cartilage and Wharton's jelly are avascular structures, and they all contain similar or closely related metachromatic substances. They all bear the same peculiar relationship to their blood supply, and consequently their nutrition must be similar. Our assumption gains support from the findings of Barcroft *et al.*[1].

Finally, it is significant that the cornea is the only tissue with which successful homografting can be carried out, and the explanation may lie in its chemical structure and peculiar nutritional conditions

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Mechanism of Bacterial Flocculation caused by Protozoa

WITHIN the last two or three years several investigators[1-4] have reported in these columns that certain Protozoa growing in sewage possess the power of causing flocculation of the bacteria on which they feed, a property which is obviously of value to the organisms themselves, since it facilitates the collection of food bacteria, and may also be of importance in sewage purification.

So far as I am aware, the mechanism of this peculiar phenomenon has not been described. In the holotrichous ciliate *Balantiophorus minutus*, the ability of which to cause such flocculation has already been recorded[5], it has been found that the feeding mechanism involves the production of mucus, secreted within the peristome, to which the food bacteria adhere before being ingested, and are thus prevented from being swept out of the peristome by the ciliary currents. This mucus has been found gradually to accumulate in the culture-fluid and, not being a diffusible substance, remains in the neighbourhood of the ciliates themselves. The resulting local increase in the viscosity of the culture medium causes the entanglement and flocculation of the bacteria. When floccula from *Balantiophorus minutus* cultures are examined under the microscope, the bacteria are seen to be cemented together by an amorphous substance which, upon staining with methylene blue, with mucicarmine and Delafield's hæmatoxylin, or with safranin, shows the metachromatic effect characteristic of mucin with these dyes. Control cultures of the same mixed bacterial flora which have not been inoculated with the ciliate show no flocculation ; and smears, upon staining, give sharp monochromatic coloration, no matrix being visible between the bacteria.

This matter is dealt with more fully in another publication at present in the press.

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Effect of Temperature on Fertility of the Male

EXPERIMENTAL work on many mammals, including dogs, rabbits, cats, rams and bulls, has shown that in those species with the testicles enclosed in an external scrotum, there is normally a significant temperature difference between the testicles and the body. This temperature difference varies in different species from 1° to 8° C. and is essential for the proper functioning of the testicles. If the temperature of the testicles is artificially raised to body temperature, sperm production is greatly lowered and the animals concerned may to all intents and purposes become sterile. There is, of course, no diminution of desire.

The experiments of Young[1] may be cited as typical of the work which has been carried out on this subject. Young ran hot water (46–47° C.) over the testicles of guinea pigs for periods of 15–30 minutes. He found that some degeneration of the germinal epithelium began immediately and that the consequent diminution of fertility was apparent for twelve days.

This knowledge has important practical application in animal breeding. For example, the sterility of a valuable strain of rams in Australia was shown recently to be due to nothing more than a thick growth of wool on the testicles. When this source of warmth was removed, the fertility of the rams was restored. The sterility of an undescended testicle is apparently due to its being kept at body temperature. If the testicle can be massaged down into the scrotum, it produces sperms.

McLeod and Hotchkiss have reported[2] experiments in this connexion on the human subject. Healthy young men were exposed in a fever cabinet to a temperature of 110° F. for a period of 32 minutes. For eighteen days after the experiment, their sperm counts remained at a normal figure of 300–400 million. The counts then fell to as low as 20 million and remained subnormal for sixty-seven days. Medical evidence quoted in the same paper indicates that with a sperm count less than 60 million a man is almost certainly sterile.

No mention was made in McLeod and Hotchkiss's paper of the possible adverse effects of hot baths on mature males. I investigated this important possibility. The matron of a London hospital told me that the temperature of a patient's bath is about 105° F., which is well above body temperature. The temperature of a domestic hot bath is nearer 110° F., the temperature of the fever cabinet experiments. Dr. John Hammond, with whom I discussed this problem, is of the opinion that such a temperature might reduce human male fertility. He added the interesting information that the fertility of white men is much reduced in the tropics, and that more native children are conceived there in the cooler months. Dr. John Baker, of the School of Comparative Anatomy, Oxford, has raised the question of the possible adverse effects of hot baths purely on the evidence of work on lower mammals[3].

It is not suggested that the hot-bath habit is the sole cause of male infertility, but it would seem to be a fruitful line of research, according closely as it does with the general rise in male infertility, the reduction of the birth-rate in 'civilized' as opposed to backward nations, the greater reduction of the birth-rate in the richer sections of the community, and the peculiar fillip given to the birth-rate by the present War and the War of 1914–18.

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Naturally Occurring Polyesters

MAY I add to the recent note[1] on the isolation of a natural elastic polyester[2]? The natural occurrence of polyesters was observed as early as 1908 by Bougault and Bourdier[3], who showed that the waxes obtained by extraction of the leaves of a variety of conifers are linear polyesters of hydroxy-acids such as juniperic acid (ω-hydroxypalmitic acid) and sabinic acid (ω-hydroxylauric acid). These polyesters, or 'etholides', have average molecular weights of the order 1,000–2,000, and were afterwards shown to have the same general properties as the synthetic polyesters obtained by heating ω-hydroxy-monocarboxylic acids[4]. The average molecular weights of the natural esters show that they belong to the α-polyester type rather than the ω- or linear superpolyester type synthesized by Carothers and Hill[5]; Bougault appreciated the analogy between the etholides on one hand and polysaccharides and polypeptides on the other.

The etholides (natural and synthetic), which are polyesters derived from the self-condensation of ω-monohydroxy-monocarboxylic acids, are to be distinguished from the second class of linear polyesters synthesized by Carothers and Arvin[6] by the condensation of dihydric alcohols and dicarboxylic acids. The properties of the natural elastic polyester constituting the skin enclosing the seeds of *Smilax rotundifolia* indicate that it is not a *linear* polyester but that a degree of cross-linking of the polymer chains occurs[2].

Kemp and Peters suggest that the principal hydrolytic product of the polyester, an acid of the approximate molecular formula $C_{18}H_{36}O_5$, is a trihydroxy-monocarboxylic acid; if this suggestion is correct, the elastic properties of the natural polymer may be reproduced in synthetic polyesters derived from polyhydroxymonocarboxylic acids.

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Non-luminous Flame Gases

AFTER flame has travelled through a homogeneous inflammable mixture, the gases left behind ('flame gases') rapidly reach what is for all practical purposes a state of equilibrium. The flame gases (like ordinary open flames) are in general luminous, and their temperatures as determined by (i) calculation, (ii) fine platinum wires and (iii) quartz-covered platinum wires of the same overall diameter, differ by hundreds of degrees C. Typical temperature measurements made with combustible gas – air mixtures during the pre-pressure period in large closed-vessel explosions by means of wires of 0 0005 in. diameter are given in the accompanying table We think that the explanation is that a proportion of the tri-atomic molecules formed during combustion holds in very stable fashion an excess of energy (probably in virtue of abnormal structure), and because of this an abnormal dissociation takes place, the products of which combine on the plain platinum surface[1,2].

		Temperatures (° C)	
		28% Carbon monoxide	9% Methane
Calculated	.	2110	1860
Platinum	..	1790	1680
Quartz	..	1440	1360

In the special case of inflammable mixtures with a very large excess of combustible gas, the abnormal dissociation appears to be suppressed in the flame gases, for the plain and quartz-covered wires yield exactly the same temperatures. These temperatures are far lower than the calculated temperatures[1], and, of course, the flame gases are luminous. When, however, such mixtures undergo combustion in a tube, the flame gases, although luminous after the early stages of flame-front travel from the igniting spark, suddenly become non-luminous after further travel (due apparently to a sudden change in the mode of combustion in the flame front[1]). This rather remarkable phenomenon is vividly demonstrated in the flame photograph shown in Fig. 1, which was taken on a moving film during the explosion of a mixture (88 per cent carbon monoxide plus 12 per cent oxygen) in a glass tube.

We have recently completed a series of plain and quartz-covered wire temperature measurements with such mixtures in a closed iron tube 12 ft. in length and 4 in in internal diameter. The wires were placed axially along the tube at various points up to 20 in. from the igniting spark. The results for a mixture (90 per cent carbon monoxide plus 10 per cent oxygen) are shown in Fig. 2. It will be seen that when the flame gases are luminous the wire temperatures are more than 200° C. below the calculated temperature, whereas after 15 in (when the flame gases are presumably non-luminous) they are much greater and are nearly equal to the calculated temperature—indeed even more so than appears, for the wire temperatures are given as measured and have not been corrected for radiation loss either from the flame gases or from the wires. It would appear, therefore, that non-luminous flame gases, unlike ordinary flame gases, are just hot normal gases.

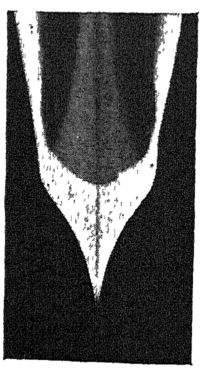

Fig. 1.

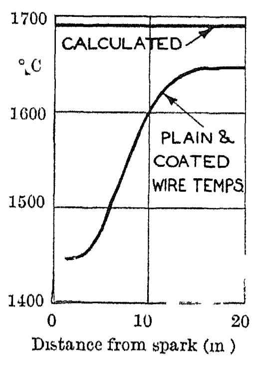

Fig 2.

It may be of interest to point out that the flame photographs of Bone and Frazer suggest that non-luminous flame gases are also produced immediately after detonation is set up[3].

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[1] *Proc Inst Mech Eng*, **151**, 236 (1944) and other papers referred to therein

[2] *Phil Mag*, **34**, 816 (1943)

[3] *Phil Trans Roy Soc*, **230**, 363 (1931), Photographs Nos 5, 17, 22 and 32

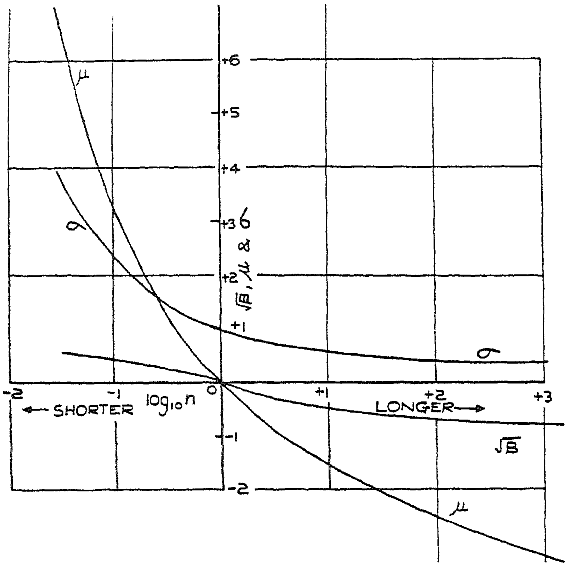
Effect of Length on Tensile Strength

THE results of a large number of tension tests on nominally identical test pieces can conveniently be represented by a frequency curve in which the ordinate gives the frequency of occurrence of test pieces the strength of which is represented by the abscissa. The frequency of occurrence of test pieces the strength of which falls between the limits $x + dx$ and x is given by $f(x)dx$. When the frequency curve is integrated with respect to x and between the limits $-\infty$ and x, an integral curve is obtained the ordinate $F(x)$ of which gives the proportion of test pieces with strength less than x. The proportion of test pieces with strength greater than x is given by $1 - F(x)$. Where the frequency curve does not depart greatly from normality, its characteristics can conveniently be summarized by its mean (μ), standard deviation (σ) and skewness $\sqrt{\beta_1}$.

It is of interest to derive the distribution of strength of rods the length of which differs from those tested. Consider first the strength of rods which are n times as long as those tested.

If the material is statistically homogeneous, such rods can be regarded as being composed of n rods of unit length chosen at random and placed end to end. Fracture will occur when the breaking load of the weakest of the n rods is reached. Owing to the predominance of low results, it would be expected that the mean strength would be lower and that the distribution would be more negatively skew than the distribution for the unit test pieces; and that the standard deviation would be lower. If $F_1(x)$ and $Fn(x)$ are the probability integrals for the strength of test pieces of length 1 and n units respectively, the distribution of the strength of the long test pieces is obtained by calculating the chance that n unit test pieces chosen at random shall all be stronger than a given strength; for this is the chance that the weakest of n test pieces shall exceed the given strength.

Thus $1 - Fn = (1-F_1)^n$. This result was given by Pierce[1].



DISTRIBUTION PARAMETERS WHEN UNIT CURVE IS NORMAL

The similar problem of determining the distribution of strength of test pieces shorter than the unit test piece does not seem previously to have been treated. Consider each unit test piece as divided up into m equal parts, and consider the distribution of strength which would be expected if each part were tested separately. Each strength figure, which had previously been obtained for the unit test pieces, would again be obtained, and associated with each of these strengths there would be $(m - 1)$ results of higher strength.

Owing to the predominance of high results, it would be expected that the mean strength and standard deviation of the distribution of the shorter test pieces would be greater than those of the distribution of the unit test pieces, and that the curve would be positively skew. The probability integral for the short test pieces $(F\ 1/m)$ is obtained by stating that the distribution of the least of the strengths of m test pieces taken at random is the same as the distribution of strength of the unit test pieces. Thus

$$\left(1 - F\frac{1}{m}\right)^m = 1 - F_1,$$

$$\text{or } 1 - F\frac{1}{m} = (1 - F_1)^{1/m}.$$

It is thus seen that the same formula holds for n less than unity (equal to $1/m$) as for n greater than unity. In the special case in which the distribution of the strength of the unit test pieces is normal, the characteristics of the distribution for other lengths have been computed and are shown in the accompanying curve. For n integral the results given by Tippett[2] have been used, while for n fractional the results have been worked out using Sheppard's Tables[3]. Values of the normal distribution beyond the range given in these tables were required and these were evaluated by Sheppard's method. The unit of the ordinates of the curves of σ and μ is the standard deviation of the distribution of strength of the unit test pieces. To obtain the mean strength of test pieces of given length, the appropriate value of μ multiplied by the standard deviation of the unit distribution must be added to the mean of the unit distribution. From the graph it is seen that both mean and standard deviation increase rapidly for fractional lengths and decrease more gradually for integral lengths. For lengths greater than unity, the distributions are negatively skew; and for lengths less than unity, they are positively skew.

The practical use of these results requires very careful consideration and as it cannot be dealt with briefly, it will form the subject of a report to be published elsewhere.

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[1] Pierce, R. H, *J Text Inst*, 17 (1926)
[2] Tippett, L H C, *Biometrika*, 17 (1925)
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Entropy of Saturated Liquid-Vapour Mixtures, and Trouton's Rule

IT is well known that the entropy of a saturated vapour usually diminishes continually as the saturation temperature and pressure increase up to the critical values. On the other hand, the entropy of the saturated liquid increases continually. At any equilibrium below the critical, the vapour entropy S_v is greater than the critical entropy S_c, while the liquid entropy S_l is less. Thus it is possible to define a mixture of saturated liquid and vapour, say, of dryness q, such that the entropy of the mixture will be equal to the entropy at the critical point. The defining equation will be

$$(1 - q)S_l + qS_v = S_c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For a number of substances, the value of q so defined varies but little over the whole range from the triple point to the critical point. Thus, for such substances, there is a particular mixture the entropy of which is approximately constant at the critical value Table 1, obtained by examining tabulated data, shows mixtures the calculated entropies of which differ by no more than 10 per cent from the critical entropy over the whole range of available data, in some cases down to the freezing point, although the vapour and liquid entropies vary widely.

TABLE 1. MIXTURES GIVING APPROXIMATELY CONSTANT ENTROPY

Substance	CH_3Cl	CCl_2F_2	CH_3Br	NH_3	CO_2	H_2O
q	0 63	0 89	0·29	0 554	0 61	0 50

Consideration of this circumstance has suggested the following discussion of a definable ideal case.

Since $S_v = S_l + \frac{L}{t}$, S_l can be eliminated from equation (1), to give

$$(1 - q)\frac{L}{t} = S_v - S_c \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now let us imagine an ideal substance such that the equation for the entropy of a perfect gas is applicable to its saturated vapour right up to a critical condition, and also such that its mixture of dryness q has constant entropy equal to the critical value. Then substitution in equation (2) will give the following expression for its heat of vaporization:

$$(1 - q)\frac{L}{Rt} = \frac{5}{2}\log\frac{t}{t_c} - \log\frac{p}{p_c} \quad . \quad . \quad . \quad . \quad (3)$$

Assuming that real substances may be considered to approach this ideal, we can substitute in equation (3) experimental values of boiling points and heats of evaporation at a given pressure, say, atmospheric, and the critical temperatures and pressures, and so calculate values of q (Table 2).

TABLE 2 CALCULATED VALUES OF q FOR IDEAL CONDITIONS

Substance	He	H_2	N_2	O_2	HCl	Cl_2	CO_2	CS_2
q	0 840	0 745	0 755	0 720	0 715	0 692	0 805	0 735

Substance	C_6H_6	C_6H_7N	NO	NH_3	C_2H_5OH	H_2O
q	0 742	0 741	0 752	0·720	0 768	0 693

It is immediately obvious from Table 2 that the values of q so calculated are nearly equal for all the substances. The average is 0·746, which is nearly equal to 0·75. This may be of significance, since it gives a whole number ratio, 3/1, of molecules in the vapour phase to molecules in the liquid phase.

Thus a number of real substances behave approximately in such a way that their heats of vaporization and boiling points at atmospheric pressure are related to their critical temperatures and pressures as would be those of an ideal substance having the perfect gas laws for its saturated vapour, and a constant entropy for its mixture containing 3 molecules of vapour to 1 of liquid. The 3/1 ratio may be related to the packing volume of spherical symmetry.

It will be clear that use of this idea, and consequently substituting $q = 0{\cdot}75$ in equation (3), will predict values of $\frac{L}{t}$, so that the suggestion gives something corresponding to Trouton's rule. But Table 3, which compares experimental values of $\frac{L}{t}$ with values calculated on $q = 0{\cdot}75$, shows it is more accurate than Trouton's rule.

TABLE 3.

Substance	He	H_2	N_2	O_2	HCl	Cl_2	CO_2	CS_2
$\frac{L}{t}$ Expt	5 1	10 8	17 3	18 1	20 7	19 2	31	21
$\frac{L}{t}$ Calc	3 3	11·0	17 1	20 2	23 7	23 6	24 3	22 1

Substance	C_6H_6	C_6H_7N	NO	NH_3	C_2H_5OH	H_2O
$\frac{L}{t}$ Expt	20 8	21 9	26 7	23 4	27 2	26 0
$\frac{L}{t}$ Calc.	21 5	22 7	26 5	26 2	25 2	32·0

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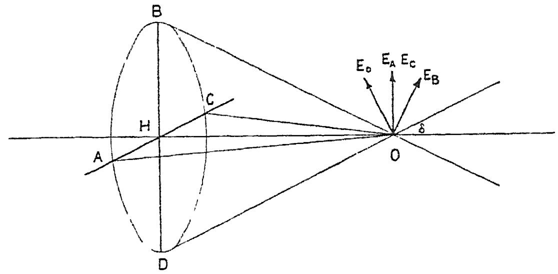
Resolving Power of the Microscope using Polarized Light

IN a recent paper[1] I derived formulæ expressing the distribution of light in the geometrical focal plane of optical systems of high relative aperture; and, using these formulæ, curves were given showing the distribution of light in directions perpendicular to, and parallel with, the direction of polarization for a system fulfilling the sine-condition, and of numerical aperture equal to 0·77. A conclusion drawn, on the basis of this work, was: "The curves . . . have bearing on the resolving power of microscopes. A variation of the resolution for two fixed points with rotation of the direction of polarization is suggested by them".



A paper has now come to my notice which confirms the existence of such a variation. In "An Application of Polarised Light to Resolution with the Compound Microscope"[2], Stump refers to a note in Carpenter's "The Microscope and its Revelations" (p. 325, 1891 edition) which records, as an unexplained fact, that by placing a Nicol analysing prism over the eyepiece "the effect [of resolution] is much strengthened". Stump examined a number of objects having minute periodic structure, and "it was found that in all cases where the prism was set so as to pass light vibrating in a plane parallel to the striæ being shown, a clearer image was formed than when the prism was not used". This is fully in accord with the results I obtained mathematically, of which there seems possible a simple physical explanation.

In the diagram, HB is the direction of vibration of the light vectors in the incident plane-polarized wave; and $ABCD$ is an annulus of the emergent converging spherical wave. Elements of the wave passing through A, B, C, D proceed to the focus at O along the ray-paths AO, BO, CO, DO. At O the disturbances associated with A, B, C, D are E_A, E_B, E_C, E_D; of which E_A, E_C have full effect; whereas E_D, E_B cancel along the direction HO, and along the direction of E_A, E_C have effective magnitudes $E_D \cos \delta$ and $E_B \cos \delta$, where δ is the angular semi-aperture of the annulus $ABCD$. Thus, relative to the meridian HC, the effective amplitude along HB is attenuated, and in the direction HC there is a greater concentration of energy in the outer parts of the wave. This state of affairs leads to a narrower diameter of the Airy disk in the direction HC, and a (relatively) broader diameter in the direction HB. That is, striæ with their lengths in the direction HB will be better resolved than those along HC.

Evidently the resolution with the prism in its position of maximum effect will be greater than that using non-polarized light. This was found to be the case by Stump (*loc. cit.*): ". . . a clearer image of the striæ was formed than when the prism was not used".

Stump attempted a very inadequate and tentative explanation of the phenomenon, and urged the use of as many separate beams as there were structural elements—claiming that the final image "would then be a composite, formed by the blending of several independent images, each showing some particular element in the structure". A photograph of the surface structure of *Amphipleura pellucida* is given in support of the claim.

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[1] *Proc. Phys Soc*, **55**, 116 (1943).
[2] *J. Roy. Mic Soc.*, 264 (1922).

BACTERIOSTATIC EFFECTS OF POTASSIUM CHLORATE ON SOIL NITRIFICATION

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AND
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In the course of studies on the kinetics of soil nitrification, using our perfusion technique[1], we have observed a remarkable inhibitory effect of potassium chlorate on the conversion of ammonia into nitrate. We propose briefly to describe some of our main findings concerning the effects of chlorate on this important metabolic process in soil.

Technique

Our technique consists in perfusing a column of soil with oxygenated fluid by a circulatory process. The fluid, which contains in solution the substances the metabolism of which is being investigated, is made to percolate through the soil into a flask where it is mixed and aerated, and whence it is made to drain again through the same soil. The process is continuous and may be maintained for an indefinite period. The soil is left intact throughout the experiment, and analyses are made only on the soil perfusate The rate of perfusion is such that no water-logging of the soil takes place The soil is well aerated and experiments in which oxygen is substituted for air have shown that aeration of the soil is, under our normal experimental conditions, optimal for nitrification.

The kinetics of metabolic events in the soil may be accurately studied by this technique, since it ensures constancy of oxygen supply and water content throughout the soil. The temperature is kept constant at 70° F. by thermostatic control. Substances, the effects of which on the course of soil nitrification are being studied, can be added to the perfusion fluid at any time in the experimental period without handling or disturbance of the soil, and the subsequent rates of nitrification can be accurately measured.

The soil is, in fact, treated throughout the experiment as a biological whole, every effort being made to ensure constancy of the environment in which the soil is exercising its metabolic changes, except in so far as changes in the environment are brought about by the products of metabolism.

The soil is usually air-dried at room temperature and sieved. The fraction 4–1 mm. is found convenient for perfusion purposes, and although any quantities may be used, depending upon the nature of the experiment, we have usually used 30–50 gm. in these studies.

Effects of Potassium Chlorate on the Velocities of Nitrite and Nitrate Formation in Soil

When ammonium sulphate solution is perfused through a soil, nitrification commences after an initial lag period, and nitrate accumulates until all the ammonia has been utilized. Traces of nitrite also appear in the early stages but disappear again as nitrification proceeds. When, however, a mixture

TABLE 1. INITIAL RATES OF NITRITE AND NITRATE FORMATION DURING PERFUSION OF 200 ML OF N/100 AMMONIUM SULPHATE SOLUTION THROUGH 30 GM OF AN ARABLE SOIL, IN THE PRESENCE AND ABSENCE OF POTASSIUM CHLORATE

Time in days from start of perfusion	Nitrite γ N/ml perfusate		Nitrate γ N/ml perfusate		Nitrite + Nitrate γ N/ml perfusate	
	In absence of $KClO_3$	In presence of M/2000 $KClO_3$	In absence of $KClO_3$	In presence of M/2000 $KClO_3$	In absence of $KClO_3$	In presence of M/2000 $KClO_3$
1	2	3	4	2	6	5
3	5	8	12	10	17	18
4	5	13	17	8	22	21
5	5	23	28	5	33	28
7	2	44	55	2	57	46

of ammonium sulphate and potassium chlorate is perfused through soil, nitrite accumulates instead of nitrate. The sum of the nitrite and nitrate, formed by the ammonia oxidized, is only slightly affected by the chlorate when this is used in relatively small concentrations. Typical results are shown in Table 1. They show that chlorate exercises a specific inhibitory influence on the conversion of nitrite into nitrate, and that the mechanisms concerned with the initial oxidation of ammonia are practically unaffected. The results also supply direct proof that oxidation of ammonia in soil to nitrate proceeds *via* the intermediate formation of nitrite While few have seriously doubted that nitrite is an intermediate in this process, the evidence so far has been indirect and could not be regarded as supplying satisfactory proof of the essential intermediate role of nitrite

Effects of Potassium Chlorate on Nitrite Oxidation in Soil

When sodium nitrite is perfused through soil. rapid oxidation to nitrate takes place after an initial lag period due presumably to the slow development of nitrite-oxidizing organisms in the soil. The presence of chlorate at so low a concentration as $M \times 10^{-5}$ markedly inhibits the process. Typical results are given in Table 2, which show that sensible inhibitory effects occur with 2.5×10^{-6} M chlorate.

TABLE 2 RATES OF NITRITE OXIDATION ON PERFUSION OF 200 ML OF M/280 SODIUM NITRITE SOLUTION THROUGH 30 GM OF GARDEN SOIL IN THE PRESENCE AND ABSENCE OF POTASSIUM CHLORATE INITIAL VALUE OF NITRITE $N = 333\ \gamma$/GM SOIL

Concentration of $KClO_3$ added to perfusate	Time in days from start of perfusion							
	3	4	5	6	7	8	9	11
	Percentage nitrite oxidized							
Nil	0	60.6	98.7					
2.5×10^{-6} M	0	43.2	71.7	95.4	98.1			
5.0×10^{-6} M	0	20.7	38.1	59.1	89.1	96.9		
10.0×10^{-6} M	0	22.2	35.4	50.4	57.6	65.7	76.8	96.0

Effects of Potassium Chlorate, at Low Concentrations, on Ammonia Oxidation

Perfusion of ammonium sulphate through the soil in presence of very small concentrations of potassium chlorate has given results which show that although nitrite accumulates, it disappears in time. This disappearance is apparently not due to destruction of chlorate, because chemical and biological tests have indicated that chlorate is still present when nitrite oxidation has been completed This phenomenon of nitrite accumulation is shown in Fig. 1. It will be observed (from Curves 4 and 5) that when relatively high concentrations of nitrite are formed, a long

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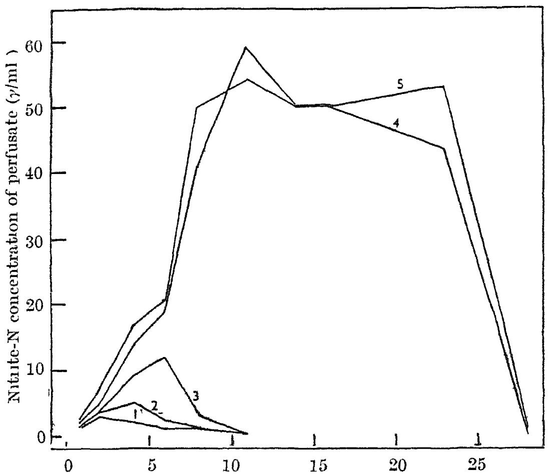

Fig 1 EFFECT OF POTASSIUM CHLORATE ON NITRIFICATION OF 200 ML $M/200$ AMMONIUM SULPHATE BY 30 GM OF ALLOTMENT SOIL Conc. of potassium chlorate present Curves 1, nil, 2, $M/540,000$, 3, $M/180,000$, 4, $M/60,000$ 5, $M/20,000$

latent period of about fourteen days elapses before the nitrite disappears. After this period the rate of nitrite oxidation is normal Since chlorate is still circulating at the end of the experiment, it follows that the oxidation of nitrite takes place in spite of the presence of the chlorate.

This result is consistent with the view that the chlorate does not markedly retard the actual chemical process of nitrite oxidation in the soil to nitrate, but rather that it inhibits the proliferation of those cells responsible for this oxidation The initial burst of nitrite formation is due to the fact that the development of the ammonia-oxidizing organisms is unaffected by the chlorate, whereas that of the nitrite-oxidizing organisms is very greatly reduced The latter do, however, develop slowly, presumably during the long latent period, until sufficient cells are produced to account for the final fast phase of nitrite oxidation

It is, in fact, characteristic of the action of chlorate that it causes an initial lag, of variable duration, in the rate of oxidation of nitrite. This is seen in the results given in Fig. 2, which show the rates of nitrite oxidation, in presence and absence of chlorate, on perfusion of $M/280$ sodium nitrite solution through soil. That the nitrite is completely oxidized to nitrate has been verified by analyses of the perfusion fluid It is noteworthy that the rate of nitrite oxidation in presence of chlorate, *after* the initial long lag period, approximates to that obtained in the absence of chlorate.

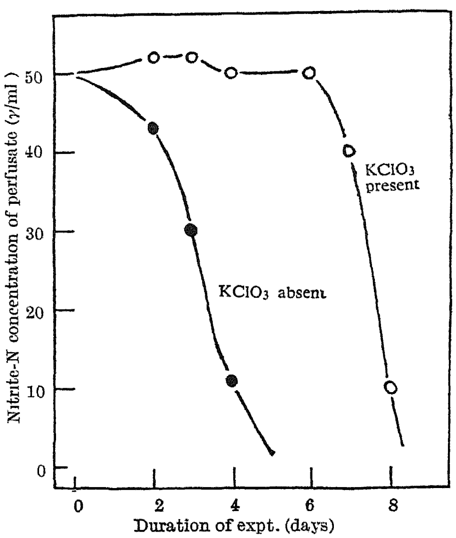

Fig. 2. NITRITE OXIDATION IN THE PRESENCE OF $M/10,000$ CHLORATE (FRESH SOIL).

Effects of Chlorate on a Soil Enriched with Nitrite-Oxidizing Organisms

If the view is correct that chlorate exercises its inhibitory effect largely by retarding the proliferation of nitrite-oxidizing organisms and not by poisoning the oxidative mechanism involved in nitrite utilization, it follows that chlorate should not prevent nitrite oxidation in a soil which has been enriched with the appropriate organism

For experiment, soils were perfused with water alone and with sodium nitrite solution containing 50 γ of nitrite nitrogen per ml for four days (until the nitrite was completely utilized). After this period, the perfusion fluids were changed, the soils were thoroughly washed with water and re-perfused with fresh solutions of sodium nitrite, with and without the addition of potassium chlorate. The velocities of nitrite disappearance were measured and are shown in Fig. 3. They show that chlorate exercises a small inhibition of the rate of nitrite oxidation in a previously nitrite-perfused soil, but that there is no initial lag period in the rate of nitrite disappearance. The same phenomenon occurs with soil previously perfused with water, though the subsequent rates of nitrite utilization are somewhat less. These results are consistent with the view that nitrite perfusion in a soil (in absence of chlorate) enriches it with nitrite-oxidizing organisms, which can then bring about their oxidations even in the presence of chlorate. Water perfusion of a soil results in a similar (though smaller) enrichment of these organisms owing to the fact either that traces of undecomposed nitrites are present in the soils, or that nitrite is being formed from the nitrogenous matter still in soil. A soil, however, initially perfused with chlorate (and con-

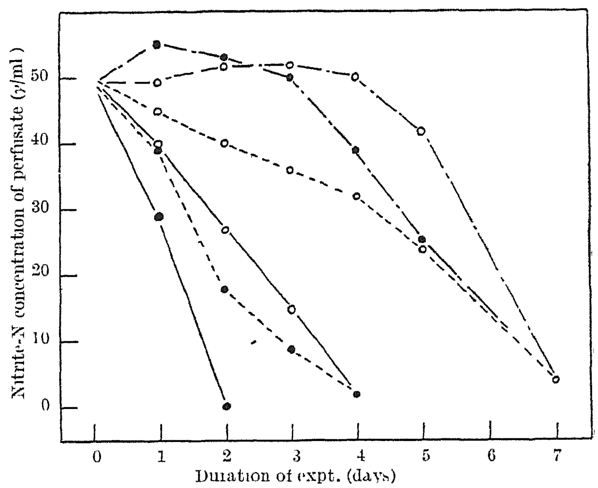

Fig 3 INITIAL PERFUSION - - -, WATER, —, NITRITE, - -, CHLORATE SECOND PERFUSION ●, NITRITE ALONE, O, NITRITE PLUS $M/10,000$ CHLORATE

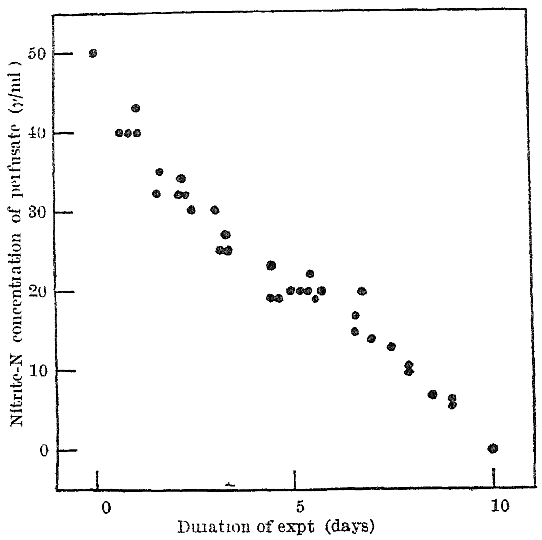

FIG 4 NITRITE OXIDATION IN THE PRESENCE OF CHLORATE (SOIL ENRICHED WITH NITRITE-OXIDIZING ORGANISMS)

taining therefore but few nitrite-oxidizing organisms) shows on subsequent perfusion with nitrite a lengthy time lag before the nitrite undergoes oxidative change (see Fig. 3).

Rate of Nitrite Oxidation in Soil in Presence of Chlorate

It would be expected that if the main effect of chlorate, at low concentrations, is to prevent proliferation of nitrite-oxidizing organisms, the velocity of nitrite oxidation in a soil enriched with these organisms would be a constant in the presence of chlorate. The velocity would be proportional to the number of cells initially present; it would not increase with time, in the presence of chlorate, as it should if proliferation were taking place.

The results of four separate experiments are included in the data given in Fig. 4, in which the nitrite content of the perfusion fluid at any moment is plotted against time. The soils were enriched with nitrite-oxidizing organisms by initial perfusion with sodium nitrite, and then they were perfused with $M/280$ sodium nitrite solution containing potassium chlorate. Three concentrations of chlorate, $M/10,000$, $M/20,000$, $M/40,000$, were used, but much the same results were obtained with all three.

Fig. 4 should be a straight line if the velocity of nitrite oxidation is constant. It will be seen that there is a close approximation to linearity, indicating the largely bacteriostatic action of chlorate.

TABLE 3 RATES OF NITRITE OXIDATION ON PERFUSION OF 200 ML $M/280$ SODIUM NITRITE CONTAINING $M/2000$ POTASSIUM CHLORATE THROUGH 50 GM GARDEN SOIL, IN THE PRESENCE AND ABSENCE OF NITRATES

Concentration of sodium nitrate added initially to perfusate	Time in days from start of perfusion								
	0	3	5	7	10	12	14	17	19
	Nitrite N,γ/ml. perfusate								
Nil	50	54	51	55	55	56	52	52	50
$M/400$	50	54	50	54	51	48	45	25	0
$M/200$	50	53	50	50	48	45	36	14	0
$M/100$	50	56	47	40	20	0			
$M/50$	50	39	29	20	0				

Effects of Nitrate on Chlorate Bacteriostasis

The action of chlorate in inhibiting the oxidation of nitrite in soil is partially or completely eliminated by the presence of nitrate. If a solution of sodium nitrite containing potassium chlorate is perfused through soil containing initially a relatively high concentration of nitrate, little or no retardation of nitrite oxidation is exhibited Results given in Table 3 show how increasing concentrations of sodium nitrate in the perfusion fluid have increasingly large effects in neutralizing the action of chlorate

This result demonstrates that nitrate alleviates the bacteriostatic effect of chlorate. The effect of nitrate is apparently specific, for no such alleviation is accomplished by phosphate, borate, chloride, sulphate, arsenate or *p*-aminobenzoate.

This phenomenon is possibly related to that described by Crafts[2] and by Hurd-Karrer[3] in which nitrate reduces the toxicity of chlorate to plants.

Experiments are now being carried out to discover how nitrate exercises its neutralizing effects on chlorate inhibition.

Summary

Potassium chlorate at low concentrations (c. $M \times 10^{-5}$ to $M \times 10^{-6}$) exercises a bacteriostatic action on soil organisms oxidizing nitrite to nitrate. The effect is specific, as chlorate at these concentrations has little or no effect on the conversion in soil of ammonia into nitrite. Chlorate administration to a nitrifying soil thus results in nitrite accumulation. Chlorate has little or no effect on nitrite oxidation in a soil which is rich in nitrite-oxidizing organisms. Its effect at low concentrations seems almost wholly concerned with the inhibition of the proliferation of these micro-organisms.

The bacteriostatic action of chlorate is specifically neutralized by the presence of nitrate, the alleviating action of which increases with its concentration.

[1] Lees and Quastel, *Chem and Ind*, 238 (1944)
[2] Crafts, *J Agric. Res.*, **58**, 637 (1939).
[3] Hurd-Karrer, *Amer. J. Bot.*, **28**, 197 (1941).

WAR-TIME MEDICAL PROGRESS IN AMERICA

"ONE of the memorable experiences of this war," writes Prof. D. W. Bronk, in his contribution to the symposium on war-time advances in medicine held by the American Philosophical Society (*Proc. Amer. Phil. Soc.*, 88, 151; 1944), "is to stand at evening in the Great Court of Trinity College, Cambridge, outside Isaac Newton's rooms, and watch the Flying Forts return." More memorable, some Cambridge residents might add, was the unforgettable sight, sudden and wonderful after dark years of trial, of the sky one summer evening full of the aeroplanes and men going out on the first one-thousand bomber attack. Such developments have been made possible by the work, in Great Britain and in the United States, of men like Prof. Bronk, who is professor of biophysics at the University of Pennsylvania and co-ordinator of research, Office of the Air Surgeon, Headquarters Army Air Forces. His contribution to this symposium discusses such human problems of aviation as the effects of rising, as modern fliers do, to heights of six miles in six minutes, the effects of high-speed manœuvres in machines built to withstand the stresses involved (although the human body is not) and problems of night flying and vision.

Such problems could no doubt be classified under the heading of environmental effects, and Colonel G. F. Doriot, of the Quartermaster Corps, shows in another article how profoundly these affect the soldier and the sailor. He points out, also, that we are all concerned with protection from the environment Clothing, he thinks, has been largely developed for the purpose of dressing the shop window and not to suit the particular tasks of the wearers. His discussion, illustrated by diagrams, of the problems raised by the clothing and equipment of the soldier and sailor, who have to operate in many different climates and have to be able to withstand rapid changes from one set of external conditions to another, has many applications to civilian life. The fighting man needs flexible clothing which is either warm or cool as the conditions demand Colonel Doriot pleads for more technical education in the scientific principles of rational clothing than those engaged in the textile and clothing industries get at present; in this respect they compare unfavourably, he suggests, with a number of other industries Fundamental researches are required. To select only one detail, Colonel Doriot rightly considers the problem of boots of great importance, and this point is also emphasized by Prof E. A. Strecker, of the University of Pennsylvania, in his article on neuropsychiatry. The foundations of morale, Prof. Strecker says, are simple and obvious things, such as satisfactory living conditions, good, appetizing and well-cooked food, comfortable and nice-looking uniforms and, above all, easy-fitting shoes. Sport and diversion are also important. His discussion of fear, which can, he says, no more be suppressed than the heart-beat can be stilled, is full of common sense. Important for those at home is his statement that morale fell when soldiers heard of strikes in the coal and other industries.

Another problem of the environment is discussed by Prof. J. L. Gamble, of Harvard Medical School, in his article on the water requirements of castaways, a subject which has been much studied in Great Britain as well as in the United States (see, for example, Macdonald Critchley's Bradshaw Lecture on "Shipwreck Survivors" (London. J. and A. Churchill, 1943) and the work sponsored by the Medical Research Council Committee on the Care of Shipwrecked Personnel). Assessing the water requirement during fasting with little or no physical activity at about 700 c.c., Prof. Gamble describes experiments which indicate that at least 100 c.c. of this can be replaced by glucose or other food sugars or starches, with all the physiological advantages of this replacement, without disturbing the water balance. There was an appreciable water gain in subjects who drank 500 c.c. of sea water every day (3–4 litres would be needed to cover the daily water requirement of a castaway and even 500–600 c.c. would cause disturbing effects). In these subjects extracellular fluid volume was conserved by the gain from sea water and by increased withdrawal from intracellular water. Experiments done near Cape Cod in hot weather indicated that periodic immersion or wet clothing completely prevented loss of water above the basal rate. Solar radiation without a breeze caused loss of water at ten times the basal rate (more than 2 litres were thus lost by one subject, who, in six hours, thus wasted enough water to cover his intake need for three days). Shade, periodic immersion and wet clothing completely prevented this. Most impressive of all was the protection from water loss afforded by a breeze (fortunately rarely absent). The castaway's great risk is therefore hot, wind-less weather.

Dr. E. J. Cohn, of Harvard Medical School, contributes a valuable article on blood, blood derivatives and blood substitutes, with a bibliography of forty-eight references, mostly American. The contents of this paper can only be briefly indicated. It discusses plasma proteins, the dimensions in Angstrom units of these proteins and those of suggested blood substitutes, the equilibrium between the albumins and globulins of plasma and the tissues, the dissociation of the globulin molecules of plasma, the separation and concentration into fractions of the plasma albumins and globulins and their stability when separated. The article also discusses the use of gamma globulin antibodies for the prevention of measles and of iso-hæmagglutinins in the typing of blood. The remarkable properties which the long, rod-shaped molecules of fibrin confer on fibrin films, made from fibrinogen and thrombin, are described. These films can be used as substitutes for the dura mater in neurosurgery of the brain. Their mechanical properties recall those of plastics; they can, for example, be stretched to twice or three times their original length or made into seamless tubing. Fibrin foam, made also from thrombin and human fibrinogen, may be, when it is dry, of two types. One type is light, fluffy and highly compressible; it wets easily, losing 90 per cent of its dry volume by shrinkage. The other type is dense, firm and less compressible; it wets slowly and then loses only about 50 per cent of its dry volume. Fibrin foam is used for stopping bleeding from veins or oozing surfaces, but not for stopping arterial hæmorrhage; it is useful in neurosurgery. By appropriate control of their preparation, other types of fibrin-clot can be made, some of which are used in surgery or for skin-grafting.

Prof. C. S. Keefer, of Boston University School of Medicine, deals with the use of penicillin in the treatment of various bacterial infections, and Prof. A. O. Whipple, of Columbia University, also discusses this substance, together with others, in his article on recent advances in the treatment of wounds. R. E. Dyer, assistant surgeon-general, United States Public Health Service, writes about immunology. He directs attention to recent improvements in the immunizing potency of typhoid vaccine and the discovery and improvement of vaccines against yellow fever and typhus fever and of tetanus toxoid. Compulsory use of tetanus toxoid has removed the menace of tetanus from the United States military and naval forces; we are informed that tetanus is, for the same reason, no longer a menace to British fighting men. Further improvements in these and other immunizing procedures may be expected before long.

Perhaps the most thought-provoking article in the symposium is that contributed by Prof. R. J. Dubos, the discoverer of gramicidin. Drug therapy, he argues—and many experienced observers will agree with him—constitutes only one facet of the complex problem of infection, and we should not be led away from these other aspects by the spectacular and popular appeal of recent chemotherapeutic achievements. Our difficulty is not to prepare more and more antibacterial substances, but to find out how they act in the body. They do not act as gross protoplasmic poisons, but selectively inhibit some vital process in the parasite's life. We need much more work on the problem of how they act.

There have been, on the other hand, important epidemiological and immunological advances towards

the control of such serious diseases as smallpox, yellow fever, diphtheria and infestations with such animal parasites as the hookworms and the schistosomes. We should study the host-parasite relationship much more, including micro-organisms among the parasites, and get away from the rather narrow channels into which the very rapidity of the success of serological and immunological research has directed investigation The whole picture should be studied by resuming broad biological and biochemical studies of the host and its bacterial and animal parasites. So far as the bacteria are concerned, the study of the complex property of parasites which we call virulence is important. A given parasite can cause epidemics or disease only when it has been able (1) to reach a susceptible host, (2) to overcome the cellular and humoral defences of that host, (3) to multiply in it, and (4) to damage it. Each of these factors can vary independently of the others. In order to cause an epidemic, the parasite must possess them all at the same time. A highly pathogenic strain of hæmolytic streptococci, for example, may have only a low degree of communicability, and the converse may be true of other strains. The study of the resistance of the host is likewise very important, and there are other factors which the epidemiologist must consider. Prof Dubos believes that we shall eventually be able to predict the course of epidemics and to organize 'listening posts' which will detect qualitative and quantitative changes in the number of infectious agents and in those of their properties which affect their virulence. A beginning in this direction has already been made.

It is a matter for conjecture, Prof. Dubos considers, whether preventive chemotherapy will ever become advisable or effective, but preventive immunological treatment can certainly be effective, as immunization against smallpox, typhoid, diphtheria and other diseases has shown. High degrees of immunity produced by means of killed bacterial cultures are, however, very specific and do not protect against related organisms of another immunological type, so that type-specific immunity protects against only the particular organisms concerned. For this reason, effective immunization of whole populations with type-specific vaccines may be impossible It is, nevertheless, possible in some instances, for example, the pneumococci, to direct the immune response against a component of the bacterial cell which is common to all types of pneumococci. Possibly bacterial cell components will be found in all bacterial groups which can be attacked in this way, so that we may eventually be able to immunize against all the types of each group. The non-specific immunization of this kind which has so far been achieved is, however, lower than that produced by type-specific vaccines, but more research into it might enable us to raise its potency. We have hitherto studied type-specific immunization almost exclusively Immunization techniques, moreover, have been up to now primitive in their principle of killing the pathogenic organism with heat or antiseptics. It is certain that a very large percentage of the material injected in anti-typhoid vaccination has no immunological value at all and even causes unfavourable reactions in those to whom it is given. It is very important to isolate the chemical components of the cell which do produce the immunity. If we could do this, we might, in the distant future, prepare artificially the substances required to produce the immunity.

G. LAPAGE.

ORGANIZATION OF INDUSTRIAL RESEARCH

FUTURE historians will no doubt record that the opening decades of the twentieth century were characterized by the beginning of a systematic application of the results of scientific research to everyday life and the consequent foundation of research organizations, both large and small, mainly devoted to the best utilization of new knowledge in the service of commerce and industry Moreover, these organizations, staffed by professional research workers together with technicians and other assistants in considerable numbers, stood out in striking contrast to the research conditions of the days of Faraday, Joule and Kelvin, when even advanced technological research was an entirely private venture It is often forgotten to-day how young in years organized industrial research really is, and that while there are certain industries, such as heavy chemicals and electrical engineering, which have expanded on a vast scale with laboratories widely distributed over Great Britain, there are also other industries, deeply rooted in history, having as yet no medium for the exploration of fresh ideas and wholly dependent on traditional techniques.

At a meeting of the London Branch of the Institute of Physics on February 17, Dr R E Slade, speaking from a wide practical experience, dealt with those factors which he regards as essential to the successful organization of research in the laboratories of manufacturing firms where most industrial research is now done

Dr. Slade began by pointing out that the laboratory must be a well-run unit constituting an integral part of the firm's activities and in full sympathy with the industry which it is trying to serve. Research is admittedly an individualistic operation, and its success is not a mere question of organization, though organization can facilitate the performance of the work; for this reason, the director or research manager should himself be an experienced researcher, able to inspire the workers under him, but suiting his methods to the personalities of the various section leaders "There is room in every laboratory for a scientifically trained organizer to do the administrative work for the director, so as to relieve him of as much administrative work as possible." The ideal chemical research laboratory would thus consist of a director and an administrator with six section leaders, five having charge of researches and the sixth looking after services including the library, analytical department and workshop. Probably the most efficient size of industrial chemical laboratory would have sixty to a hundred university-trained workers and up to four hundred other workers. There is always a tendency for a laboratory to increase in size, but while it is cheaper to allow this rather than start a second new laboratory, it is not advisable to let the laboratory become so big that the director cannot know all his men and be prevented from exercising his personal influence and encouragement. "Not only do we want laboratories with distinctly different outlooks, but we want in each laboratory men with different kinds of training who will look at problems in different ways and tackle them in different ways, too."

Dr. Slade does not believe that the direction of a laboratory can be carried out effectively by a committee; he admitted the utility of advisory panels, but

emphasized that the success of the laboratory depends upon the director being a research worker, capable of directing the laboratory, and having also the capacity of making a committee believe that it is directing the work when he is in reality leaving it to the common sense and ability of the section leaders. Moreover, if a company is to gain full value from its research department, there must be a director on the board of management who knows what research might do for it, and this director should himself have had research experience.

Industry must be alive to developments which may take place in any of the sciences; for example, the chemical industry needs to employ mathematicians, physicists, metallurgists and biologists. In regard to physicists, it would seem that they have not in the past been used to full advantage, for they have often been engaged as narrowly specialized technicians such as X-ray crystallographers and spectroscopists, instead of being given the opportunity of examining industrial problems in their entirety and so determining how best physical knowledge may be applied and what factor needs to be measured and to what degree. Similarly, the metallurgist should not be brought in, for example, when pipes have already corroded and broken down, but should be given the opportunity to see that industry has pipes that will stand up to manufacturing conditions.

One of the great problems of present-day industrial research lies in the difficulty of acquiring new specialized techniques as they appear. No laboratory is big enough to keep a specialist in every possible technique, and so workers have to be sent to the originator of the technique as students. This method is too slow for industry, and Dr. Slade thinks that a national central laboratory of scientific techniques should be set up to serve industry in this field.

The cost of research is £1,500–£3,000 per annum per university-trained research worker employed, including assistants, mechanics, glass-blowers and services. Though high, the cost is fully justified by the results. Those carrying out research should have some authority to purchase equipment up to a reasonable sum, otherwise absurd cases will occur where men earning perhaps £600 a year or more are kept on unimportant work for weeks while a committee decides whether to spend £60 on a piece of apparatus.

Great importance should be attached to the linking of the research laboratory to the utilization of the products by the consumer; hence the director should learn to look at his problems from the point of view of the production manager and of the sales manager, and orient some of his researches accordingly.

After referring to the way in which the thirty research associations of Great Britain assist the special industries to which they are attached, Dr. Slade then described in detail a method of linking research and industry, as carried out at the Mellon Institute in America, where manufacturers may have a specific piece of work carried out by endowing a fellowship for a number of years; in this way valuable work has been done on such diverse materials as limestone products, furs and their by-products, plastics, solvents, pesticides, rosins, high-boiling products, etc.

It is not in general desirable for university departments to carry out technological research; though industry has obtained its scientific outlook from the men it has recruited from the universities, and while important discoveries may be made in industrial laboratories, we shall always be dependent upon the universities for the most fundamental work and for new ideas, so nothing should be permitted to limit this vital function of the universities.

Dr. Slade concluded by stating that research thrives in an atmosphere of freedom, enthusiasm and achievement, and the aim of the organization of industrial research should be that of creating the best conditions for the individual workers with the view of applying knowledge and research to improve the arts of industry

A particularly vigorous discussion followed the address, from which the following points, expressed perhaps in somewhat disjointed form, may be noted. Many good men are lost to research through promotion to administration. The researcher should have knowledge of what is practically possible in the craft of his industry; industry is suffering because problems are not being dealt with on a large enough scale, and there is need for co-operative research on a bold and comprehensive plan Pooling of ideas will not result in lack of competition A spirit of national service is requisite for industry in peace-time as well as in war-time Workers should not be handicapped by having to write regular detailed reports of their work while it is in progress, but it is better to write a comprehensive report at the end. The cost of development and advertisement of results is bound to be relatively high in relation to the cost of the original research; it has therefore been suggested that exploratory research be limited by allocating, say, 20 per cent of research grants to original work and 80 per cent to development. The workshop is vital in research laboratories, and all workers should be able to carry out certain simple operations themselves and be able to make sketches of new apparatus, though very complicated drawings may be left to a draughtsman. Several speakers, including Dr. Slade, deplored any suggestion that a central committee should decide what fundamental work each laboratory should undertake; though the opposite view was also expressed that in the interests of humanity some direction should be given as to what are socially desirable researches.

H. LOWERY.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, March 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly London, W.1), at 2 30 p m.—Annual General Meeting. Mr. A. S. Kennard: "The Early Digs in Kent's Hole, Torquay, and Mrs. Cazalet" (Presidential Address).

Monday, March 5

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5 p.m.—Mr. J M. Wordie. "North-West Greenland and North Baffin Island" (Kodachrome Film).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. D. Tiranti: "The Need for Administrative Engineering".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W 3), at 7.45 p m —Mr. E. A. Roth: "Technical and Economic Problems of Post-War Agrarian Policy in Central Europe".

Tuesday, March 6

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p m.—Dr. S. A Huzayyin: "Further Light on the Upper Palæolithic of Egypt".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M, Pres.R.S.: "Nerve Endings and Chemical Transmitters", (1) "Actions of Involuntary Nerves and of Substances which Mimic or Paralyse their Effects".

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (in the small Physics Theatre, Imperial College of Science, Prince Consort Road, South Kensington, London, S W 7), at 5 30 p m.—Prof G. I. Finch, F.R S "Electron Diffraction"

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6 30 p m —Dr L Northcott and Mr D McLean "The Influence of Centrifugal Casting upon the Structure and Properties of Steel"

Wednesday, March 7

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2) at 1 45 p m —Mr R F. Wilson: 'Colour as a Factor in Industrial Design".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 2 30 p.m —Mr. Henry W. Robinson "Robert Hooke and the Importance of his Work in Medicine and Biology"

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S W 7), at 3 30 p m —Dr W E. Ripper "Recent Advances in the Control of Agricultural Pests"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C.2), at 5 30 p m —Dr K R Sturley · "Frequency Modulation"

Thursday, March 8

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly London, W 1), at 2.30 p m —Mr G O K Sainsbury Photograph of a remarkable specimen of *Pseudopanax crassifolium* C Koch—an Adult Tree with a Reversionary Shoot on the Trunk, at 2 50 p m —Prof J McLean Thompson "The Study of Plant-Behaviourism a Common Meeting-Ground for future enquiries by Morphologists, Geneticists Anatomists, Systematists and Physiologists Alike"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p m.—Sir Lawrence Bragg, F R S. "Some Physical Problems of the Solid State".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place Victoria Embankment, London, W C.2), at 5 30 p m —Mr. L S Atkinson "Modern Electric Lift Practice"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W.1), at 6 30 p m.—Mr. C. G Woodford 'Electrics for Aircraft"

Friday, March 9

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St James's Park, London, S W 1), at 10 30 a m —Conference on Surface Finish (A series of twelve Short Papers in five Groups · Group 1, Physical Aspects, Group 2, Methods of Measurement and Representation · Group 3, Considerations of Rational Specification and Requirement in Surface Finish; Group 4 Production Methods and Results of Modern Practice. Group 5, Effect of Surface Finish on Production.)

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 3 15 p m —Annual General Meeting, at 4 p m —Mr S Ernest Melling · "Water and Water Supplies" (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p m —Scientific Papers.

PHYSICAL SOCIETY (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S W.7), at 5 p m —Mr. W E Ballard "The Formation of Metal-sprayed Deposits" Mr R F Bishop Mr. R. Hill and Prof N F. Mott, F.R.S.. "The Theory of Indentation and Hardness Tests".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m —Prof David Brunt, F R S.. "Climate and Human Comfort"

Saturday, March 10

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Swansea), at 2.30 p m —Inaugural Meeting Dr. C. Sykes "Physics in Metallurgy" *

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Municipal Offices, Town Hall Street, Blackpool (endorsed 'Borough Electrical Engineer') (March 10).

ASSISTANT TEACHER OF MATHEMATICS at the School of Building, East Ham Technical College—The Chief Education Officer, Education Department (T), Town Hall Annexe Barking Road, East Ham, London, E 6 (March 10)

RESEARCH ENGINEER immediately to organize and control Laboratory and Experimental Department of progressive manufacturing company situated in N.W. London area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No. C 2462 XA) (March 12).

FOOD AND DRUG ANALYST for service with large Company operating in the Middle East—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C 2 (quoting Reference No. F.2894.XA) (March 12).

TEACHER OF ELECTRICAL ENGINEERING SUBJECTS, a TEACHER OF MECHANICAL ENGINEERING SUBJECTS, a TEACHER OF MATHEMATICS, and a TEACHER OF CHEMISTRY (to teach PHYSICAL and INORGANIC CHEMISTRY to Honours Degree standard)—The Principal, Acton Technical College, High Street, Acton, London, W.3 (March 12).

SENIOR (Reference No C 2485 A) and JUNIOR (Reference No C 2486 A) ENGINEERS (mechanical and electrical) to carry out work of national importance in a Government Department (location London) —The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting the appropriate Reference No) (March 16)

SUPERVISORS (PRODUCTION ENGINEERS, 3) for TELEGRAPH WORKSHOPS at Calcutta, Jubbulpore and Bombay, for manufacture of stores connected with Telecommunication Development—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No C 2484 A) (March 17)

ADDITIONAL OFFICER for Secretarial and Organizing work (applicants should be chemists with organizing and administrative ability)—The Hon Secretary and Registrar, British Association of Chemists, 175 Piccadilly, London, W 1 (endorsed 'Additional Officer') (March 31)

GARDEN STEWARD (woman) with responsibility for the upkeep of about 50 acres of gardens and grounds—The Secretary, Girton College, Cambridge (April 10).

MALE TECHNICIAN, with some knowledge of section cutting and staining, for Anatomy Department—The Secretary, Medical School, St Thomas's Hospital, London, S E 1

EDUCATIONAL PSYCHOLOGIST—The Director of Education, County Hall, Kendal, Westmorland

GRADUATE IN BIOLOGY (candidates must be able to teach CHEMISTRY and PHYSICS in relation to BIOLOGY and HYGIENE) at the Folkestone Day Technical School for Girls—The District Secretary Kent Education Committee, at the Technical Institute, Ashford, Kent

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research Tyroglyphid Mites in Stored Products, 1 A Survey of Published Information, Supplement 1944 By M E Solomon Pp 8. (London H M Stationery Office, 1944) 2d net [12

Royal College of Physicians of London Social and Preventive Medicine Committee. Second Interim Report, January 1945 Industrial Medicine Pp 24 (London Royal College of Physicians, 1945) [12

Imperial Bureau of Animal Health Review Series, No 2 Modes of Spread of *Streptococcus agalactiæ* Infection in Dairy Herds, a Report on Co-ordinated Observations organised by the Agricultural Research Council of the United Kingdom. Pp iii+27 (Weybridge · Imperial Bureau of Animal Health, 1944) 3s [12

Monographs of the Quekett Microscopical Club The Discovery of the Uses of Colouring Agents in Biological Micro-Technique. By Dr John R Baker Pp 22. (London Williams and Norgate, Ltd, 1945) 1s 6d [22

British Rubber Producers' Research Association Publication No 55 The Structure of Polyisoprenes, Part 2 The Structure of β-Guttapercha By G A. Jeffrey Pp 4 (London British Rubber Producers' Research Association, 1944) [22

Hannah Dairy Research Institute List of Publications, 1928–1944 Pp. 16. (Ayr: Hannah Dairy Research Institute, 1944) [52

British Electrical and Allied Industries Research Association Twenty-fourth Annual Report, October 1st, 1943, to September 30th, 1944. Pp 127 (London British Electrical and Allied Industries Research Association, 1945) [72

Other Countries

Commonwealth of Australia Council for Scientific and Industrial Research Bulletin No 180 Studies on Deglutition in Sheep 1. Observations on the Course taken by Liquids through the Stomach of the Sheep at Various Ages from Birth to Maturity, by R H. Watson, 2 Observations on the Influence of Copper Salts on the Course taken by Liquids into the Stomach of the Sheep, by R. H. Watson and I. G Jarrett Pp 126+7 plates Bulletin No 181. Sheep Blowfly Investigations—The Attractiveness of Sheep for *Lucilia cuprina* By I M. Mackerras and M J Mackerras Pp. 44+2 plates (Melbourne. Government Printer, 1944) [181

Government of Travancore Administration Report of the Government Museum for the Year 1118 M E. Pp 8 (Trivandrum Government Press, 1944) [241

South Australia. Department of Mines. Mining Review for the Half-Year ended 31st December 1940 (No 73) Pp 96 Mining Review for the Half-Year ended 30th June 1941 (No 74) Pp 56 Mining Review for the Half-Year ended 30th June 1942 (No 76) Pp 98 Mining Review for the Half-Year ended 31st December 1942 (No 77) Pp 81 Mining Review for the Half-Year ended 30th June 1943 (No. 78) Pp 138 Mining Review for the Half-Year ended 31st December 1943 (No 79) Pp 128 (Adelaide Government Printer, 1941–1944) [241

South Australia. Department of Mines, Geological Survey of South Australia, Bulletin No 19 The Underground Water of the South-Eastern Part of South Australia. By Dr. L. Keith Ward Pp. 56. Bulletin No 20 The Structural Control of Ore Deposition in some South Australian Copper Fields. No 1 A The Wallaroo-Moonta Field, B The Dome Rock Copper Mine, C. The Mount Gunson-Pernatty Lagoon District, D. The Burra Burra Mine, E. The Callington-Mammantoo District. By S. B. Dickinson. Pp. 99 Bulletin No 21 The Structural Control of Ore Deposition in some South Australian Copper Fields No 2. F. Kapunda Mines, G Blinman Mine, H. Sliding Rock Mine, I Lady Lehmann Mine. By S. B. Dickinson. Pp. 6. (Adelaide. Government Printer, 1941–1944) [241

Derris Agronomy: an Annotated Bibliography and a Critical Review. By R. E Moreau (Reprinted from the *East African Agricultural Journal*) Pp 24. (Nairobi Government Printer, 1944.) [241

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REHABILITATION OF EUROPEAN CULTURE

THE encouraging measure of agreement reached by Mr. Winston Churchill, President Roosevelt and Marshal Stalin at the Yalta meeting, as indicated in the communique issued on February 12, goes far to offset some of the doubts as to common policy which have arisen since the tentative proposals of the Dumbarton Oaks Conference were issued last October. Agreement has been reached on the difficult question of voting procedure in the Security Council of the new peace organization, and a Conference of the United Nations is to be called to meet at San Francisco on April 25, 1945, to prepare the charter of such an organization along the lines proposed at Dumbarton Oaks.

The declaration on liberated Europe is the most important of the three parts into which, apart from the military plans, the statement falls naturally. It is true that European policy cannot be sharply separated from the treatment of Germany, but without some common European policy and without the reconstruction of civil life and the full restoration of social, economic and cultural activity, in which science has a prominent place along with other intellectual activities, there can be no hope of any adequate solution of the German problem.

That problem will probably provide the most searching if not necessarily the first test of the adequacy of any new world organization, and it is the appearance of lack of harmony in the policy of Great Britain, of the United States and of the U.S.S.R. towards the liberated countries of Europe during the last six months that has given such a shock to public opinion. The three Governments—and the statement expresses the hope that the provisional Government of the French Republic may be associated with the three Powers in the procedure suggested—declare their mutual agreement to concert their policies, during the temporary period of instability in liberated Europe, in assisting the peoples of Europe to solve by democratic means their pressing political and economic problems. The establishment of order in Europe and the rebuilding of national economic life must be achieved by processes which will enable the liberated peoples to destroy the last vestiges of Nazism and Fascism and to create democratic institutions of their own choice. To foster the conditions in which the liberated peoples may exercise their sovereign rights and self-government, the three Governments pledge themselves to give joint assistance where required, in their judgment, to establish conditions of peace ; to carry out emergency measures for the relief of distressed peoples ; to form interim Government authorities broadly representative of all democratic elements in the population and pledged to the earliest possible establishment through free elections of Governments responsive to the will of the people ; and to facilitate, where necessary, the holding of such elections.

The declaration, which provides for consultation

with the other United Nations in Europe when matters of direct interest to themselves are under consideration, thus proposes to proceed from world order to peace, and though it may be objected that there are areas in Europe which are not yet ripe for democratic institutions, over a large part of liberated Europe this implementation of democracy should be effective and appropriate. Further, the second proposal—emergency measures for the relief of distressed peoples—is one that may well at once provide an effective means of education in democratic methods and the touchstone of the sincerity and determination of the three Great Powers subscribing to the Yalta Declaration.

There is in fact no question touched upon during the recent conference that is of more immediate concern to Great Britain than that of relief for the liberated countries of Europe. Grave anxiety regarding the relief of France has already found expression in the House of Commons and in the Press, and has not been dispelled by either Mr. C. R. Attlee's statement or the more recent one of Mr. Richard Law. The concern is shared by the troops serving on the Continent, and on all sides there is evidence that a more generous, imaginative and positive policy would be welcomed, and indeed is essential if the goodwill we found on the Continent is not to run to seed. The criticism of, and charges of grave weaknesses in, the United Nations Relief and Rehabilitation Administration which Dr. H. V. Evatt, leader of the Australian delegation, uttered at the opening session of the Conference of that body at Lapstone are in keeping with growing uneasiness which has been apparent since its council met at Montreal in September.

Much of the criticism that has been levelled against the United Nations Relief and Rehabilitation Administration may in fact be unjustified, for since the first session of its council met at Atlantic City in November 1943, a large organization has been built up and much information gathered about the needs to be met and the supplies available to meet them. So far, however, the actual relief work in the liberated areas of Western Europe has been done by the military authorities in conjunction with the French and Belgian Governments. Dr. Evatt argued from this that it was doubtful whether the Administration would perform all the duties intended under the terms of its charter, and urged that there must not be the same delays in the Far East that have occurred in Europe. Further, he said that administration was over-centralized and that wider national representation was needed at all levels of the administration and staff.

It is expected that U.N.R.R.A. may shortly be allowed to send supplementary supplies to certain countries, such as France, Belgium and Holland. This will involve a complete departure from the general principle of that body, that it will not operate in a country until invited to do so by the Government in power, and, in Western European countries who wish to pay for their supplies, until the relevant financial negotiations have been completed. While the new proposal releases the organization from the strictures that have in the past prevented it from dealing promptly with emergencies, it in no way affects the general schemes for providing relief in bulk in accordance with the original terms of the charter.

Though it is clearly unfair to blame U.N.R.R.A. itself for the present position, even given the limitations on its activities imposed by its charter, public opinion is not disposed to hold the Government entirely free from blame in this matter. Mr. Richard Law's statement in the House of Commons on February 13 with reference to relief appeals for allied and liberated countries will not allay misgivings on this point, for it showed lack of insight and imagination. His statement on February 14 on the economic and supply position in the liberated countries of Western Europe, while satisfactory so far as it went, did not remove the impression that the military authorities, to whom the matter had been left, have not shown sufficient foresight. The main failure, Mr. Law said, has been in distribution, but the national governments cannot be held entirely responsible because not only were the means of transport lacking but also the administrative machine had become seriously impaired and had to be rebuilt. No one will deny that the first objective of the military authorities must be to wage war and to wage war effectively, or that the requirements of our liberated allies are in direct competition with urgent military demands. Equally it cannot be denied that the position is one where high policy is also involved, and where the Government cannot evade the responsibility for rapid and decisive action.

What appear to be lacking are the imagination and warmth of sympathy already evident in public opinion. There is in the Government's statements no appreciation of what might be the effect of announcing that we were to release, for example, some of our own ample stocks of fats for France and Belgium, where the deficiency is so great. It is not yet forgotten in Europe that Mr. Churchill, when Secretary of State for War in 1919, not only opposed the continuance of the blockade of Central Europe as endangering a collapse of the entire structure of German social and national life, but also had earlier sought on Armistice Day to send six food ships to Hamburg. It is all a matter of the right priorities. We have large reserves of many other foodstuffs which were regarded as essential when the climax of the War still seemed distant but which could be safely reduced now. Even a reduction of food rations in Britain might be considered for the critical few weeks, provided that the urgency were explained fully to the people.

What is most essential is a clear understanding of how dangerous the alienation of France may become, and of how urgent it is not merely to meet the need but also to seize the chance to restore France. When that is realized there can be no hesitation over the decisions to be taken to divert transport from the more obvious military needs to the more urgent but no less vital needs of the political and economic

warfare against the same enemy. Here, as throughout the War, has been the weakest spot in our strategy; the rapid reconstruction of Europe is in fact not merely the background against which all relief work, whether through the United Nations Relief and Rehabilitation Administration or not, should be viewed, but also an essential condition of victory, without which military success may be sterile.

Nor should it be imagined that relief and reconstruction have physical or material aspects alone. The reconstruction of France and of Europe is a cultural and spiritual task also. Even now, six months or more after the liberation of France and Belgium, cultural contacts have scarcely been established except in the most desultory manner. Import of French books has not yet been resumed, and the Government's own policy with regard to paper for books removes all hope at present of providing France with the British scientific and other books which she awaits. Without such interchange and collaboration there cannot come the full understanding between the two great Western democracies which must be a prelude to their closer co-operation in the reconstruction of Europe, in whatever form that may ultimately take.

The abatement of national prejudice and passion, and the mutual sacrifices which are involved in building any form of world order, will not be made in moments of sentimental impulse. They will arise out of a clear understanding of what is involved and the deliberate surrender of the lesser to the greater ideal. That is the substance of Prof. D. Mitrany's argument in "The Road to Security"*. He sees the only basis of security in positive and constructive action in the social and economic fields. An international organization cannot limit itself to the negative purpose of restraining aggression: in a world of change, it must also help to bring about constructive change.

Prof. Mitrany, in this little pamphlet, brings out very clearly the relation between national planning and world order. International peace cannot be considered as consisting only in the prevention of violence. We must take account of social unity and economic development, and it was the failure to do this that broke the system of common order represented by the League of Nations. If once more we conceive of security as merely a matter of policing the world against the use of violence, we may well find divisions in the economic world—competition in shipping and aviation, for raw materials and trade —even more acute than during the twenty years of truce. Even the aspirations for full employment and social security, with the national planning and State action involved, may threaten security unless national planning is geared from the outset to international planning.

In fact, the organization envisaged at Dumbarton Oaks will be futile, Prof. Mitrany believes, unless we develop joint economic arrangements sufficiently comprehensive and far-reaching to prevent a split between the participating Powers. Such arrangements would go far towards protecting States, especially the economically weak States, from economic aggression, and remove the temptation to try aggression for economic and social ends. Moreover, certain agencies are already available for that purpose, as Prof. Mitrany points out, and as is further indicated in the P E P broadsheets which have been brought together and re-issued under the title "Building Peace out of War". Economic technical agencies would be preventive, by their very nature, in a way in which military agencies never can be. Just as it would be their function to give service wherever it is needed, so it would be their duty to deny service where it is not obviously needed and might be abused.

Stress is laid by Prof. Mitrany on this withdrawal of services as an effective form of sanctions, but the most important point is undoubtedly that they are a step towards dealing jointly and resolutely with the very springs of war. The real problem of security and the task of statesmanship are not to keep the nations peacefully apart, but to bring them actively together, and in such a task science has an essential part to play. As is pointed out in the P E P broadsheets, in building European unity, parallel with the establishment of a framework of order and security must go the reconstruction and development of European life in the direction of a social, economic and cultural community which all its citizens have a common interest in maintaining and furthering, and to which all will eventually come to feel a loyalty commensurate with their loyalty to their own countries. Moreover, the key to the restoration of social stability will be the rebuilding and development in new forms of those cultural and other institutions and associations which are the life-blood of a free community, but have been persecuted or suppressed by totalitarian Germany—universities, churches, trade unions, professional organizations, the free Press and radio.

Linked with the rebuilding of institutions is the gradual development of individual leaders in every sphere, and here the emphasis must be on individuals, not governments, for in a Europe functioning as a community the individual leaders of industries, trade unions, universities and other vital institutions are as important as those of regional governments. In such a process the universities of Europe, which inherit the tradition of European unity, must take a central role, whether or not there is linked to them, as is suggested by P E P, as centres of post-graduate training and research, one or more special European staff colleges for the training of Europe's key administrative personnel.

There can be no doubt that, as is stated in the final study of this volume, the people of war-ravaged Europe will look to Britain for help and guidance in picking up again the scattered threads of the European tradition, and in rebuilding the institutions in which it is largely embedded. But since that broadsheet was written in 1943, the problem and the task have

* The Road to Security. By Prof. David Mitrany. Pp 20. (Nat. Peace Council, 144 Southampton Row, London, W.C.1, 1944.) 4d.

become urgent and imperative. The situation is desperate, and it is no longer merely a matter of urging that the advance of science demands the resumption of normal free communication and contact the moment military exigencies permit: it is rather that unless the physical task of relief and reconstruction is undertaken forthwith, military success may be sterile. Even now the physical task demands all the help and inspiration it can draw from the cultural life and the institutions which enshrine the tradition of European unity and the highest ideals of its intellectual and spiritual life.

It is in fact a moral obligation that rests on scientific workers to press for the re-establishment of contacts with their colleagues in liberated Europe, and to co-operate with them in building up once more the tradition and institutions of learning and research which Germany has sought to extirpate The task of reconstructing the universities of Europe is immense, and in the physical sphere little may yet be practicable. But already the planning of such reconstruction is an urgent task, and a generous response to the desperate needs of Europe on the part of scientific workers, no less than of other men of learning and culture, might have an immense effect in establishing an atmosphere of understanding and goodwill and in giving new hope. What are required above all are vision and imagination to sense the possibilities, as well as the dangers, and to grasp the significance of the European cultural contacts and institutions which the Committee on Intellectual Co-operation once represented, not merely in providing the leaders required to-morrow, or in establishing the freedom of thought, of utterance and of investigation, but in creating that sense of European community of interest, of confidence, which brings fresh hope, in place of frustration or despair, and without which the sore-pressed peoples of Europe might have no heart to address themselves to that task of reconstruction.

BOTANY IN BRITAIN

British Botanists

By John Gilmour. (Britain in Pictures Series.) Pp. 48+8 plates. (London: Wm. Collins, Sons and Co., Ltd., 1944.) 4*s*. 6*d*. net.

THE history of science has for so long been written from the point of view of chemistry and physics, with generous recognition of astronomy and even geology, but with almost complete indifference to biology in any form, that it is encouraging to note the recent development of interest in the records of early botanists and zoologists. A brief and accurate history of British botany, written with the knowledge that the late Dr. Gunther on one side and Dr. Agnes Arber on the other have made available to us, is a very valuable help to such development. Mr. John Gilmour's book is excellent and timely.

To survey a history which covers four such changeful centuries; to tell the story of so large and so varied a succession of students; to keep a sense of proportion so that the outstanding developments of the science are not lost in a mass of detail; and to present the story with all its human interest and charm and excitement as a fascinating adventure; this fourfold task Mr. Gilmour has discharged with eminent success. There are inevitably gaps, particularly perhaps in the early stages of the story: the present reviewer would plead for recognition of Thomas Penny, the friend of De l'Obel and De l'Ecluse and chief author of the "Theatrum Insectorum", and of Thomas Willisel, the first professional field-naturalist, employed by Merret and then by the Royal Society, and the discoverer of many of our rarer plants, particularly in the Pennines and Teesdale. But to compress the record into forty-eight pages, many of them half-filled with pictures, is necessarily to cut it down to the barest skeleton. That Mr. Gilmour has nevertheless found room for such delightful descriptions as that of Stephen Hales' Sunday at Teddington and for clear hints as to the relationship between botanical studies and the general ideas and culture of the time is proof of real skill as a writer as well as real knowledge as a historian. We notice only one slip in matter of fact: Bilson, not Bilster, is the name of John Goodyer's employer on p. 13.

The book, like others of the series, is almost lavishly illustrated, and here too Mr. Gilmour has chosen his pictures with discrimination. They cover a very wide range of subjects, are representative of different aspects and moments of the story, and thus are a real contribution to the record.

It is much to be hoped that Mr. Gilmour will carry on with work in this field. There is no satisfactory history of botany, and few subjects supply more abundant and more interesting material. He has evidently got a thorough knowledge of very much of what is generally available, and possesses the three-fold qualification—a thorough knowledge of botany, an understanding of historical method and research, and the power to write vividly and accurately. We hope that the success of this small essay will encourage him to a large-scale work.

C. E. Raven.

REJUVENATION OF PLANT GEOGRAPHY

Foundations of Plant Geography

By Prof. Stanley A. Cain. Pp. xiv+556. (New York and London: Harper and Brothers, 1944.) 5 dollars.

IN a recent review of "Historical Plant Geography" by the late Prof. E. V. Wulff[1], reasons were given for thinking that the subject had been revitalized by the recent application to it of methods and information developed and acquired in other scientific fields. It now appears that while these changes were leading Prof. Wulff to write his book in Leningrad, they had, in the United States, caused Dr. S. A. Cain similarly to set about accumulating material for this comprehensive volume on "Foundations of Plant Geography".

Though both works convey the indication of the opening of a wide territory for scientific investigation, they differ considerably in scope and emphasis. Prof. Cain's book is conspicuous for its reference to a very large body of work by the great American phytogeographers, such as Asa Gray, Fernald, Marie Victorin and Gleason, with their very numerous and able followers. One cannot indeed help the reflexion that the North American continent has offered, and still does offer, greater advantages to the plant

geographer than any other continental area. The circumstance was long ago pointed out that the mountain-range direction from north to south did not hinder the great vegetational movements made under compulsion of the climatic shifts of the Ice Age, and there now persists a tremendously rich flora distributed in patterns the meaning of which we at last begin to glimpse.

Among the most striking resolutions achieved so far we may mention (1) the per-glacial survival of species described by Fernald in the Gaspé peninsula and equivalent areas, (2) the work of Miss Lucy M. Braun to demonstrate the preservation of Tertiary mixed forest in the southern Appalachians, and the differentiation and migration of later vegetation types therefrom, (3) the history of migration and evolution of the genus *Vernonia* in the south and east of the United States worked out by Gleason, and (4) the remarkable history of western American forest types established by Chaney and Mason from fossil and distributional evidence throughout the Cenozoic period.

Nowhere has the study of genetics and its application to the problems of the mechanism of speciation been given more enthusiastic attention than in the United States, and Dr. Cain's book is characterized (in contrast with that of Prof. Wulff) by a sustained attempt to clarify the relation between modern cytogenetics, evolutionary theory and problems of plant distribution; indeed, about half the book is occupied by discussion of topics in this field. It is evident that the phenomena of speciation are so distinctly concerned with genetic isolation, which itself is closely correlated with geographic isolation, that progress in knowledge of evolution and of phytogeography alike demands an increasingly critical investigation of the distributional data of plant populations. The recognition of this situation makes great demands (as it presents great opportunities) to the modern plant geographer. He may not assume that the 'species' of taxonomists, his chief working material, are by any means equivalent in status or origin, he must not assume that the first-described species type is necessarily the basic form from which later-described varieties are derivative, and he must always be prepared to submit his collected material to intensive genetic and cytological analysis.

The way in which Dr. Cain attempts to integrate the cytogenetic approach with recent knowledge of geological and climatic history can be illustrated by a quotation (p. 432): "In such a region, especially after glacial recession has commenced, there are numerous new, variable and closely associated habitats in which populations of a variety of species can live in rather close proximity. The result of this intermingling of species may be the production of hybrids, followed sometimes by amphidiploidy. With continued glacial recession, the polyploids and back-crosses are in a position to expand their area tremendously. Some of the diploids also may extend far on to the glacial plain, but most of them will probably have only limited expansion. The chances of such polyploids spreading into unglaciated territory to any considerable extent seems unlikely because penetration of closed communities is more difficult."

The reality of such a mechanism as this remains to be established, like that of so many hypotheses for similar distributional and evolutionary situations; but it will be apparent how usefully the book directs attention to the considerable progress recently made in definition of problems and recognition of new approaches.

We may note a few incidental features of general interest which indicate the progress of phytogeographic ideas in the last decade or two. General opinion is shown to have swung over (partly as a result of the teaching of Willis) from regarding endemics as relict, to regarding them in many instances as recently evolved; it is now said that "some geographers believe in the efficacy of long-distance dispersal for many types of organisms, but the weight of evidence in most cases seems to be strongly opposed to such an assumption"; centres of preservation of plants throughout the ice age are freely accepted to have occurred even in northern territories.

Prof. Cain is well aware that in attempting to synthesize the results of many sciences he lays himself open to attack from the specialists in all of them. We shall here only give a single general and constructive criticism. It is stressed that there is necessity for migration of biotypes into new areas if there is to be reasonable chance for new ecotypes to arise. Geographers and ecologists may easily overlook that the habitat may, so to say, migrate to the species, rather than the other way round. By this I mean that we should view plant populations, not as living under stable conditions, but against a background pattern of ceaseless climatic change, with small seasonal shifts at one end of the scale of frequency and amplitude, and glacial epochs at the other. Especially if this alteration affects a topographically varied territory, there is then little need to invoke migration to precede the differentiation of ecotypes.

The section headings will convey the content of the book: (1) Introduction; (2) Palæoecology; (3) Areography (that is, distribution patterns); (4) Evolution and Plant Geography; (5) Significance of Polyploidy in Plant Geography. There are an immense bibliography and a useful glossary.

H. GODWIN.

[1] *Nature*, 152, 490 (1943)

MEASUREMENT OF COLOUR

The Measurement of Colour

By Dr. W. D. Wright. Pp. vii+223. (London: Adam Hilger, Ltd., 1944.) 30*s*. net.

A BOOK by Dr. W. D. Wright may confidently be expected to be first class, and the present publication is ample justification for such a prophecy. Colorimetry depends mainly upon classical physics for most of its theory, and luckily the conceptions involved are to some extent quasi-mechanical, which is probably the reason why applications to industry and technology have been both rapid and successful. The reviewer's task may thus best be implemented by discussing some of the more important of these developments in the light of the guidance afforded by the volume before us. Before so doing, however, there are a few features of wider significance. One is the way in which the fundamental character of certain optical instruments and processes is laid bare; for example, the additive trichromatic colorimeter, the photo-electric tricolorimeter and the three-colour process of colour reproduction. The reader can see from the diagrams exactly what functions must be fulfilled, unmolested by photographs or descriptions of particular types of apparatus. Incidentally, what searching examination questions these topics would provide: to describe simply and directly the necessary and sufficient conditions that the required ends

(often very involved) may be achieved. It would certainly not be easy to do it better than it is done here. Something of the kind found a place in the best German books of the nineteen-twenties, but they lacked the stimulus to deep comprehension on the reader's part which Dr. Wright has managed to introduce.

Another question treated with unusual clarity is that of the human retina, especially from the point of view of Polyak's work (1941). This leads naturally to a comparison of the wave-length and relative luminosity positions of the scotopic (low brightness) and photopic (high brightness) curves, the former for rod (monochrome) vision, and the latter for cone (coloured) vision. Artists and the like are well aware, empirically, of the darkening of red surfaces with diminishing illumination, a species of Purkinje effect for which the relative displacement of the scotopic curve towards higher frequencies is responsible. Although perhaps not directly concerned, psychologists will read this portion with interest, since implicit in these energy relations is supposedly the nature of the connexion between 'fact' and 'correlate'. It may well be that the useful, though problematical, concept of isomorphy will be unable to stand up in its present form against increasingly exact knowledge of retinal reactions. There are other complications, no doubt, but a better biophysics of colour-vision is evidently on the way.

Now for some of the applications. Many industrial matters demand the fixing of minute colour differences rather than absolute 'norms'. The Hardy spectrophotometer is excellent here, since much of the work may be concerned with reflexion, where the accuracy is most favourable. I have witnessed Hardy's machine at work upon reflectance measurements of specially prepared artists' pigments. Even allowing for somewhat elaborate calibration and checking, the speed at which the curves could be constructed was remarkable. As Dr. Wright points out, one must not cavil at Hardy's inability to cope perfectly with fluorescence or specular reflexion, since these troubles are inseparable from the system. Nevertheless, the latter component can now be wholly included or wholly excluded, thus removing uncertainty It is characteristic of the author's practical attitude that he adds a number of methods, more or less approximate, applicable to cases where complete spectrophotometry would not be justified. Much can be done by these means, so long as the absorption wave-length curve does not change direction too abruptly.

A chapter is devoted to colour atlases. These common adjuncts clearly suffer from the disadvantages of being incapable of supplying more than a fraction of all discernibly different colours and, moreover, they fade and get dirty. Nevertheless, they have their uses, as Dr. Wright explains. An interesting forecast is that we might "in, say a hundred years' time", be able to do our colour matching and selection by means of the tristimulus values, X, Y, Z, alone. Meanwhile, we are driven by some psychological urge to ask for a pattern, transient as it may be. Musicians say they can appreciate perfectly a melody by reading the score; it is hard to see why artists should not do likewise some day, and obtain colour-harmony from the appropriate algebra.

Several other intriguing outlets for colorimetry follow: chemicals and their mixture, lighting, agriculture, pulp, paper and paint, signal glasses, photoelasticity and so on. In fact, their name is legion; and as if to practise what is preached, several excellent coloured charts are included, some quite novel, and all of them helpful.

The price is the crux: for what is little more than a manual, thirty shillings does seem excessive One would like to imagine a student reading this book time and time again; but if he does, he will probably have had to borrow a copy from somebody else. F. IAN G. RAWLINS.

INTERACTIONS OF HEREDITY AND ENVIRONMENT

Livestock Improvement

In Relation to Heredity and Environment By Dr J. E. Nichols. Pp. vii+208+7 plates. (Edinburgh and London: Oliver and Boyd, 1944.) 10*s*. 6*d* net

THIS book, as the author says, attempts to outline the principles and to indicate how the genetic and environmental concepts are interwoven in the idea of livestock improvement. Much original work is included in the book, especially work on problems of sheep-breeding drawn from personal observations in many different countries.

In addition to an outline of the principles and details of genetics as applied to the breeding of farm animals, other factors closely linked with genetics and affecting livestock improvement are dealt with—such as environmental aspects, type and environment, and breed construction. These latter chapters indicate some of the problems which the applied animal breeder as distinct from the pure geneticist has to take into account. Here the idea of evolution as distinct from the modern analytical aspects of genetics creeps in, and the facts given may provide a means of bridging the gap between the ideas of Darwin and of Mendel, or between those of Lysenko and Vavilov. In particular, Nichols' conception of the stratification of the sheep industry in time and space provides the palæontologist and zoologist with a concrete example of what has occurred, and is occurring, in the evolution of a species, or in the evolution of the fauna in a district. The agriculturalist's aim to control and change environmental conditions is from the zoologist's point of view a grand experiment in the evolution of animals. Throughout the book there is a number of references to work done in tropical countries; these should provide a basis for the development of the animal industry in British Colonies and other tropical countries.

The chapters on gene and character frequency, inbreeding, outbreeding and hybrid vigour, and performance and progeny testing should prove most useful to the practical breeder of livestock, as they will enable him to see how the modern science of genetics can be usefully employed to effect a short cut to his objectives. The formulæ given in several places may prove somewhat difficult to practical breeders, but they are reduced to the minimum that is necessary for proper comprehension by a student of the subject.

The book is packed with information concerning farm animals, well illustrated and has an extensive list of references to which the reader can go for further details. With government policy giving encouragement to the better breeding of farm animals, this book should meet a widespread demand from students, teachers and breeders for more information on the methods of livestock improvement.

JOHN HAMMOND.

CAUSALITY OR INDETERMINISM?

By PROF. H. T. H. PIAGGIO
University College, Nottingham

A SHORT article published in *Nature* of July 22, 1944[1], entitled "Collapse of Determinism", contained a brief statement of von Neumann's claim to have demonstrated that the results of the quantum theory cannot be obtained by averaging any exact causal laws. If one may judge from the number of communications referring to this point which have been submitted to the Editors, many regard this claim with suspicion and desire a more detailed discussion of the grounds on which it is based. Mr. W. W. Barkas[2] suggested that the existence of statistical regularity when large numbers of events are considered is incompatible with indeterminism, and that if the final result of the behaviour of a million photons were fixed, the behaviour of the first 999,000 must influence the other 1,000. Prof. (now Sir Edmund) Whittaker[2] replied that it might be profitable to consider the behaviour of tossed coins. He asked, in particular, whether the statistical regularity for this case, calculated by the ordinary theory of probability, involves the assumption of 'crypto-determinism' (that is, real determinism hidden by lack of detailed information) or merely the assumption of symmetry. This reply produced further letters, too numerous for the Editors to publish in full, and I have been asked to give a connected account of the points raised. I shall start with the experimental evidence concerning coin-tossing, and contrast it with the theoretical discussion. After this I shall touch upon similar considerations for the kinetic theory of gases. Finally, and most important, I shall give some details of von Neumann's supposed disproof of causality, and give the arguments for and against it.

Buffon, the French naturalist, tossed a coin until he obtained 2,048 heads. The results were quoted by De Morgan[3], who gave also an account of three similar experiments by his own pupils or correspondents. The arrangement by which the last toss ended with a head gave a small advantage to heads, but too small to make any significant difference. Much more extensive experiments, on somewhat different lines, were carried out by W. S. Jevons[4], who took "a handful of ten coins, usually shillings", and tossed the ten together. He made two series of 1,024 such tossings of ten coins, so that in each series 10,240 coins were tossed. The results of these six experiments were as follows:

No of heads	2,048	2,048	2,048	2,048	5,222	5,131
No of tails	1,992	2,044	2,020	2,069	5,018	5,109
Total .	4,040	4,092	4,068	4,117	10,240	10,240
Excess of heads over mean	28	2	14	−10·5	102	11
Proportion of heads	0·5069	0·5005	0·5034	0·4974	0·5100	0·5011
Excess over mean .	0·0069	0·0005	0·0034	−0·0026	0·0100	0·0011

If we examine these results, we see that it is easy to misinterpret the meaning of 'statistical regularity'. It is certainly not true, as some correspondents seemed to think, that the numbers of heads and tails are bound to be equal. In fact, the divergence from the mean actually increased from a maximum of 28 in the first four experiments, each based on roughly 4,096 tosses, to a maximum of 102 in the last pair, each based on 10,240 tosses. This is quite in accordance with theory, which, assuming that the probability of a head in one toss is 0·5, deduces that for a large number n of tosses, it is as likely as not that the divergence from the expected mean $n/2$ will exceed $0{\cdot}3372\sqrt{n}$, but it is almost certain (99·73 per cent probability) that it will be less than $1{\cdot}5\sqrt{n}$. For $n = 4{,}096$ the 'as-likely-as-not divergence' is, to the nearest integer, 22, and the 'scarcely-ever divergence' is 96. For $n = 10{,}240$, the corresponding numbers are 34 and 152. Thus the actual divergences, though larger and more one-sided than some might have expected, are quite compatible with the theory. But the phrase 'statistical regularity' really refers to the *proportion* of heads, which, according to theory, should be very nearly 0·5, with an 'as-likely-as-not divergence' of $0{\cdot}3372/\sqrt{n}$ and a 'scarcely-ever divergence' of $1{\cdot}5/\sqrt{n}$. Both these divergences diminish indefinitely as n increases. We may also estimate the theoretical divergence of the proportion by its root-mean-square or 'standard deviation'. This has the value $0{\cdot}5/\sqrt{n}$, a result which we shall contrast later with Heisenberg's Principle of Uncertainty.

We now come to an important criticism of the theory of probability on which the above calculations are based. As pointed out by Lieut.-Colonel E. Gold[5], there is an assumption of symmetry, not only in the two faces of the coin, but also in the actions of the hand that tosses the coin. When the hand was replaced by a machine, such as that devised by J. Horzelski[6], the absence of this symmetry was manifest. By a certain adjustment of the pressure actuating a lever, he obtained 98 heads out of 100 tosses. He then slightly altered the pressure, keeping the head, as before, initially upwards on the machine, and obtained only one head in the next 100 tosses. In this case the tossing mechanism is not a hidden parameter, but is visible and definite, whereas in the usual tossing it is indefinite and, so far as we can manage it, symmetrically distributed. It is possible that the excess of heads in Jevons's experiments was due to some slight lack of symmetry in his tossing conditions. Whether this was so or not, it appears obvious that *the description of reality given by the theory of probability in coin-tossing is not complete*.

It is therefore erroneous to suppose that the properties of a perfectly normal distribution must necessarily correspond exactly with physical reality, however useful they may be in giving a good approximation to the facts. We cannot disprove the existence of the details of the projection merely by claiming that they upset the purity of the normal distribution. It is rather the very purity of that distribution which goes beyond the physical facts, and so is not a complete description of reality. Similar considerations apply to the kinetic theory of gases, but in this case the symmetry assumed in the theory[7] is a much closer approximation to the actual facts. But it is only an approximation, and here, as elsewhere in classical physics, pure statistical aggregates do not exist.

This brings us to the question whether such aggregates exist in non-classical physics, in particular in quantum mechanics. We shall examine von Neumann's arguments, using for this purpose not only his well-known treatise "Mathematische Grundlagen der Quantenmechanik" (1932), but also the shorter account, in English, that he gave in Warsaw[8] in 1937, and the discussion that ensued. The starting point is an analysis of the qualitative laws obeyed by the mathematical 'hypermaximal projective' operators which correspond to the physical quantities occurring in quantum mechanics. Everything is said to be based on six laws, of which two seem more

important than the rest. One is the principle of superposition, extended to quantities not necessarily simultaneously measurable. The other may be called the principle of exact functional correspondence; for example, if an operator represents a physical quantity, then the square of the operator represents the square of the quantity.

In my opinion, however, the emphasis on these simple laws conceals the fact that other conditions of greater importance are imposed by the definition of 'hypermaximal projective' operators. This definition implies some characteristic results of quantum mechanics, and the simple laws are merely the final requirements. Von Neumann shows that aggregates are of two kinds, 'pure' and 'mixed'. The essential property of a pure aggregate is that it cannot be regarded as a mixture of two other non-identical aggregates. The qualitative laws of quantum mechanics show that the aggregates concerned must be pure, whereas all aggregates based upon causal laws, such as tossed coins or gas particles, must be mixed. Hence, he concludes, causality is incompatible with quantum mechanics, and the process of averaging causal laws, as applied in the kinetic theory of gases, cannot possibly be extended to quantum mechanics There is no need, he says, to go more deeply into the details of a supposed system which is governed by further conditions ('hidden parameters') in addition to the wave functions. These hidden parameters would upset the qualitative laws of quantum mechanics. He admits that quantum mechanics in its present form is certainly defective, and, in spite of its great success in explaining physical phenomena, may possibly, in the long run, turn out to be false. But this is true of every theory; we can never say that it is proved by experiment, but only that it is the best summing up of experiment at present known.

Von Neumann therefore concludes that there is at present no reason and no excuse for supposing the existence of causality in quantum mechanics. This conclusion is described by Whittaker[9] as not only novel and unexpected, but also almost incredible, yet he endorses it with the exultant declaration "the bonds of necessity have been broken; for certain classes of phenomena, crypto-determinism is definitely disproved".

Other comments have been more sceptical. At the Warsaw conference, the president, C. Białobrzeski, after hearing von Neumann, admitted the validity of the argument that it was impossible to fit causality into the framework of quantum mechanics, but expressed a doubt as to the logical coherence of that framework. In his opinion it is deficient because it does not take account of irreversible changes, and also because, in certain conditions of measurement, the indeterminism of the final state disappears, and the assumptions of discontinuity and indeterminism do not correspond to reality. He thought it necessary to introduce a new postulate concerning measurement. At a later meeting of the same conference a letter from Heisenberg said that the quantum theory, in its present form, could not yet give a logically coherent account of nuclear physics or of cosmic rays.

Many critics are suspicious of purely abstract arguments which make no reference to experiment. Of course, such experiments as those of Davisson and Germer on electron diffraction and of Condon and Gurney on radioactivity, though excellent as illustrations of the Uncertainty Principle, yet have no value in deciding whether this uncertainty is due only to lack of detailed knowledge, or to true indeterminism. On a somewhat different plane is the argument of Whittaker[9], who, though a supporter of von Neumann, illustrates his argument by a reference to the passage of plane-polarized light passing through a Nicol prism, and shows that the phenomena cannot be explained by causal laws governing any hidden parameters attributed to the photons. However, H. Pelzer[10] gives two models in which hidden parameters, attributed at least partly to the Nicol prism, can exist and obey causal laws. From this he infers that the arguments of Whittaker and von Neumann are incomplete, even though he agrees with their conclusion that quantum phenomena are truly indeterminate.

My own criticism of von Neumann is founded upon a paper by A. Einstein, B. Podolsky and N. Rosen[11]. By considering the problem of making predictions concerning a system on the basis of measurements made on another system which had previously interacted with it, they conclude that *the description of reality as given by a wave function is not complete*. As a wave function is a mathematical way of representing a probability distribution, this conclusion is almost exactly the same as that which I enunciated concerning coin-tossing. I therefore, with great diffidence, offer the opinion that the existence of causality has *not* been disproved. It is true that Einstein's opinion has been rejected by N. Bohr[12], but there are other grounds for supporting it. In fact, the postulate of quantum mechanics that electrons cannot be distinguished from one another appears, at least to me, not to be a statement that Nature is incomprehensible, but merely that quantum mechanics is incomplete. However, I do not wish to insist that there is no difference between coin-tossing and quantum mechanics. One striking difference is that in coin-tossing the standard deviation of the proportion of heads depends only upon the number of tosses, and can be diminished indefinitely; but in quantum mechanics the Principle of Uncertainty gives for the product of the standard deviations of the momentum and displacement a minimum value, namely, $h/4\pi$. The occurrence of Planck's constant in this result seems to show that there is something essentially new. I should find it easier to accept von Neumann's conclusions if his arguments, instead of being purely qualitative, contained this constant. Perhaps it is really concealed somewhere in the background, like a hidden parameter!

To conclude, I will quote the opinion expressed by Bertrand Russell[13] in 1936, that at present there is no decisive reason in favour of complete determinism (causality) in physics, but that there is no reason against it, and that it is theoretically impossible that there should be any such reason. But Russell does not mention von Neumann's arguments. My own conclusion is that the balance of the present evidence is rather against complete causality, but that the question is still unsettled.

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2 *Nature*, **154**, 676 (1944).
3 "Budget of Paradoxes", 170 (1872).
4 "Principles of Science", 238 (1874), or 2nd ed, 208 (1877)
5 *Nature*, **155**, 111 (1945).
6 *Nature*, **155**, 111 (1945)
7 Preston, "Theory of Heat", 4th ed., 782 (1929)
8 "New Theories in Physics", 30–45.
9 *Proc. Phys. Soc*, **55**, 459 (1943).
10 *Proc. Phys. Soc*, **53**, 195 (1944)
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CONSTRUCTION OF THE SHOOT APEX IN CEREALS AND OTHER GRASSES

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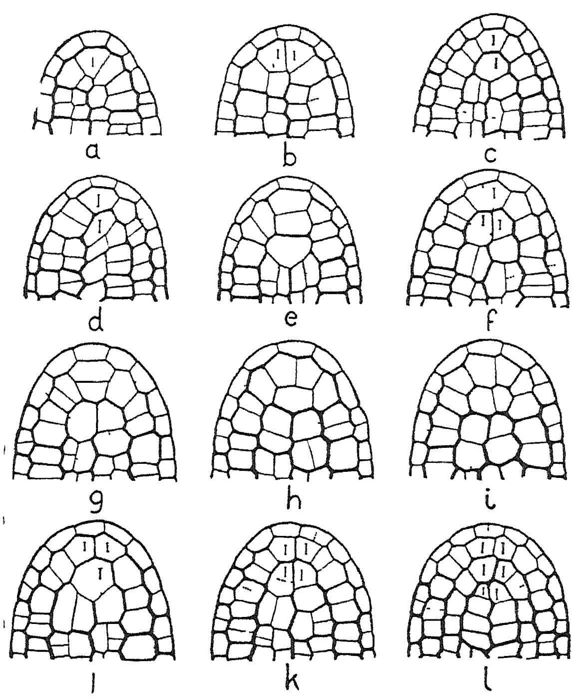
THE reawakening of interest in the developmental anatomy of the shoot apex has been paralleled by considerable advances in technique and by a growing realization that the answers to many genetical problems are locked up in a better understanding of the processes at work during the ontogeny of the organism For a number of reasons, our knowledge of apical architecture is, so far, most advanced in the Gramineæ : here we are now in the happy position of realizing that much of the early controversy arose, not from incorrect recording of facts, but from the participants failing to realize that they were dealing with separate chapters of the same story. Although all members of the family probably conform with the scheme set out in the present résumé, for convenience reference is mainly made to species already discussed in the literature.

In the Gramineæ, the apex is always a comparatively elongated structure, with the cells at the extreme tip rather larger than those in the zone of leaf initiation and with less easily stained nuclei and a suggestion of being more vacuolated. The outer cells form a single thimble-shaped layer—the dermatogen—and normally only divide anticlinally. They may sometimes originate from a single ill-defined apical 'initial', but more usually come from an even more indefinite group of 'initials'.

At the extreme tip it is often difficult to determine the arrangement of the internal cells, but a short distance back they are always found to be arranged in at least a hypodermis and sub-hypodermis, each one cell thick, which form concentric shells clothing a core of more vacuolated, less rapidly dividing tissue of a sort of 'apical pith'.

The dermatogen, hypodermis and sub-hypodermis maintain their individuality because the cells forming them divide only by anticlinal walls until a new leaf is initiated. Then successive periclinal divisions occur in the cells of the dermatogen and hypodermis, while the cells of the sub-hypodermis under the insertion of the new primordium only divide periclinally once. On the other hand, at the origin of the axillary bud the sub-hypodermal cells repeatedly divide periclinally; but those of the dermatogen, and usually the hypodermis also, only divide anticlinally.

The inner cells may originate in a variety of ways. In young seedlings and perhaps throughout most of the vegetative life of some slender grasses, they can all be traced back to a single 'segmenting' apical cell as in Fig. *a*. Sometimes (Fig. *b*) more than one apical cell is present, when the segments cut off produce the inner tissues as they are left behind. In both these types the first products of division of the one or more initials immediately divide once periclinally to give a cylinder (the hypodermis) one cell thick surrounding a core at first two cells in diameter. In older or more massive shoots there may be two superimposed initials (Fig. *c*), one giving rise to the hypodermis and the other to the rest of the internal tissue. Occasionally the situation in Fig. *d* occurs, where the inner initial cuts off cells to one side only, and these immediately divide once (the



outer cell giving the hypodermis of that side), while the upper initial cuts off cells destined on one side to be the hypodermis but on the other side to divide periclinally once, the outer cell becoming a hypodermal cell. These four types are those reputed to be usual for *Avena*[1], *Secale*[2] and *Triticum*[2] during their vegetative period, although even here a periclinal division in the 'initial' cell of the hypodermis every now and then leads to the displacement backwards of the old inner initial and its subsequent loss by differentiation (Fig. *e*). In other grasses, at least, apices can be found where there is a single 'initial' for the hypodermis and two or more for the central tissues (Fig. *f*). Here again an occasional periclinal division in the hypodermal initial leads to the displacement of the inner initial as in Figs. *g*, *h* and *i*. Fig. *h* also suggests a possible method of origin of apices of the more complex type seen in Fig. *j*, where there are two or more 'initials' for the hypodermis overlying a single one below. Similarly, Fig. *i* suggests a mode of origin of the more massive type of apex shown in Fig. *k* with two or more hypodermal initials and two or more initials below.

Progressively during ontogeny the apex usually tends to possess more initials, and the hypodermis tends to have an initial or initial group of its own superimposed upon the initial or initial groups of the more central cells. Although in the more massive types the hypodermis undoubtedly behaves as a distinct self-perpetuating layer for considerable periods, occasional periclinal divisions at the extreme tip may probably occur at any time and so lead to the displacement of the initials below. Not all species have apices of the same complexity at comparable times in their developmental history leading to inflorescence production. Thus, for example, although *Avena*[1], *Secale*[2] and *Triticum*[2] may have a separate initial or initial group for the hypodermis towards the end of the vegetative period, this only becomes a permanent feature from the time of inflorescence initiation, while in *Agropyron repens* Beauv. (un-

published) even the rhizome apex seems to have a discrete hypodermis and the aerial shoot often approximates to the state of affairs in Fig. *k*. The condition represented in Fig. *l* can be found at the tip of the developing inflorescence of *Agropyron*, but this may not be a permanent feature The possibility of three tiers of internal initials is also suggested for some of the main shoots in bamboos (*Phyllostachys*[3] and *Sinocalamus*[4]), but there is need for further investigation here.

Axillary buds have a construction either similar to or simpler than the main apex. Thus in *Avena*, *Secale* and *Triticum*, where periclinal divisions are frequent in the hypodermis at the tip of the main shoot, a similar situation is found in the apices of the axillary buds. On the other hand, in *Agropyron*, *Sinocalamus*[4] and *Zea*, where the hypodermis remains as a discrete layer at the tip of the main shoot, periclinal divisions are absent from the apices of the axillary buds.

For want of a better term, the cells to which the internal layers can be traced back in the apex have been termed 'initials', but it is only rarely that they approach anything at all like the classical idea of an apical initial. They are not large, well-defined, well-vacuolated cells cutting off segments with a volume considerably smaller than their own Instead they are usually rich in cytoplasm and divide into almost (? quite) equal parts, and the one which happens to be nearer the tip is destined to continue as the initial merely because of its position. All the cells of quite a large group are totipotent, and their positioning in the apex is probably governed by laws comparable with those which determine the packing patterns of bubbles in the end of a test tube rather than by any qualities inherent in the cells themselves. Moreover, the position taken up by a cell governs its subsequent development.

The view that the exact mode of origin of the inner tissues of the apex is not significant is further confirmed by the constant development behind the apex of the hypodermis and sub-hypodermis, often quite irrespective of details of segmentation at the actual tip, demonstrated especially by apices of the type shown in Fig. *d*. From recent studies it is becoming increasingly evident that the zonation of all apices is to be thought of in terms of levels of relative differences in aeration, nutrition, etc. It is not a morphological but a metabolic zonation rather akin to a gardener's 'top-soil' and 'sub-soil'. The nearer a cell is to the surface, the more it tends to divide exclusively by anticlinal walls, an effect which bears absolutely no relationship to the number or positioning of the 'initial' cells, and which leads to the production a little way back from the extreme tip of clearly distinguishable layers, the numbers of which will tend to be greater the more massive the apex. In grass apices of the long type this zonation will be very noticeable, but it will be masked in short apices by the divisions connected with the onset of leaf and bud initiation. The metabolic view also makes the observed occasional periclinal divisions unconnected with leaf initiation in the dermatogen itself to be expected, especially in very young axillary buds or the plumules of young seedlings.

Since the exact origin and fate of the various layers are so flexible in the grass apex, Hanstein's terminology cannot be used in its strict sense, nor is the *tunica-corpus* terminology in Buder's[5] (but not in Schmidt's[6] and Foster's[7]) sense very useful. However, using these and Koch's[8] similar terminology (originally suggested for Gymnosperms) purely as descriptive of the tissue zonation of the apex without any implications as to derivation or destiny, the equivalents are as follows:

Tissue	Hanstein	Koch	*Tunica-corpus*
Outer layer	Dermatogen	Mantle (Hullgewebe)	Tunica
Hypodermis	Outer periblem	Mantle	Tunica
Sub-hypodermis	Inner periblem	Mantle	Corpus (? or transition layer)
Inner core cells	Plerome	Central tissue	Corpus

The construction of the apex has considerable interest for the plant-breeder who wishes to obtain viable gametes by doubling the chromosome complement with colchicine, etc This is obviously best achieved by affecting the tissues eventually traceable to the hypodermis of the flower-bud primordia He need not consider whether the main axis has a single initial or a group of initials for both the hypodermis and the inner tissues, and whether or not periclinal divisions occur in the apical cells of the hypodermis of axillary buds. He must merely realize that the earlier he treats his seedling the better because: (1) in young seedlings the whole of the hypodermis is being derived from fewer initials, so that should he have the good fortune to produce a doubling in an initial, it will produce a wide sector of cells with the new constitution, and it may also be the parent of some of the other initials when the group increases in number; (2) even if he succeeds in only doubling the complement of a hypodermal cell on the flank of the apex, if effected early this will be represented in all the tiller buds from that sector, whereas successively later local doubling in the hypodermis will only affect blocks of primary, secondary and then tertiary, etc., inflorescence buds (in the case of a paniculate inflorescence), or spikelet buds and later only floret initials.

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EXPERIMENTAL MORPHOLOGY OF PTERIDOPHYTES

PHYSIOLOGICAL and experimental observations have hitherto played virtually no part in helping to elucidate problems connected with the organization of the plant body in Pteridophytes. The approach towards these problems has been almost exclusively morphological in inception and outlook. Some experimental investigations recently recorded by Prof. C. W. Wardlaw (*Ann. Bot.*, New Series, **7**, Nos. 26 and 28, **8**, Nos. 30/31 and 32, April and Oct. 1943 and April–July and Oct. 1944) dealing with bud-development and stelar morphology in ferns have yielded results of great interest and significance which indicate the value and potentialities of this previously neglected approach to morphological problems.

It has long been held that one of the morphological characteristics distinguishing ferns from seed

plants is the inconstancy in the positional relationship of buds to shoot and leaf in the former group. Though sometimes they occupy definite axillary positions, they commonly arise in extra-axillary positions which apparently show no fixed relationship to the foliar organs. Prof. Wardlaw's observations, however, suggest that, though the final position of the bud is so variable, its point of initiation does in fact show a definite relation to the foliar organs, and the ultimate position it comes to occupy is explicable in terms of relative growth activities.

Investigations on *Matteuccia struthiopteris* and *Onoclea sensibilis* have shown that, on the normally unbranched rhizomes of these dictyostelic species, buds may be induced by removal of the terminal meristem These buds are initiated in superficial areas of meristematic cells which, in the normal rhizome, remain quiescent The origin of the patches of meristematic cells can be traced to the apical meristem, from which they become detached and persist on the surface of the shoot in definite positions corresponding to the point of union of the meristeles at the distal end of the leaf gap, that is, in the axis of a leaf but some distance above its insertion.

In *Dryopteris Filix-mas*, defoliation experiments involving the removal of fronds and destruction by puncturing with a needle of the smallest visible leaf primordia proved effective in bud formation. The buds were situated either on the leaf-base near its point of confluence with the shoot or some distance along the petiole. Investigation showed that the buds always arise on the shoot in an approximately axillary position, despite the abaxial position at some distance above the petiole base which they eventually may come to occupy. Their origin was traced to the activity of epidermal cells lying in close proximity to points of meristele conjunction in the vascular meshwork of the shoot and therefore comparable in position with those of the other species investigated.

The position which the bud ultimately comes to occupy on the petiole is due to the very great transverse growth expansion of the basal region of a developing leaf primordium. This causes displacement of the much more slowly growing bud from its original axillary position, and leads to its being carried up on the enlarging base of a developing frond. The enlarging frond base on which the bud is thus caught up may lie in a longitudinal or a lateral position with respect to the bud, so that the bud may become separated in space from the leaf to which it originally stood in an axillary relationship.

Further observations along these lines may well reveal that the point of origin of buds is fundamentally the same in all ferns, and that the varied positions which they eventually occupy may be wholly explicable in terms of specific growth distribution in shoot and leaf.

In the field of stelar morphology, chief consideration has always been devoted to fully differentiated tissue systems ; and though a fairly complete picture has been obtained of the progressive increase in complexity of the stele during ontogeny, little attention has been paid to the development of the shoot as a whole from the apex backwards. Hence developmental studies in the stelar morphology of ferns, comparable in detail with the ontogenetic studies of their reproductive structures or with the dynamic aspect of tissue differentiation behind the growing point in the Angiosperms, are not available.

Prof. Wardlaw recognizes two phases in the development of vascular tissues, namely, the "initial differentiation", whereby vascular tissue can be distinguished from cortical tissue, and the "subsequent differentiation" characterized by the specialized development of the constituent vascular elements. It is in the region situated immediately below the apical meristem that the "initial differentiation" takes place, and it is suggested as a working hypothesis that this initial differentiation of vascular tissue is inseparably connected with the immediate proximity of an apical meristem in a state of active growth, its position and behaviour being causally related to one or more unspecified substances diffusing from the meristematic cells.

Evidence adduced for the Pteridophytes in general is fully in accord with the fact that wherever an actively growing apex is present, vascular tissue may be observed in the process of differentiation immediately behind it. Moreover, that the maintenance of the actively meristematic condition is all-important is indicated by the disappearance of the zone of initial differentiation behind dormant apices. It is shown that the discontinuous vascular strands which have been described by Holloway in large prothalli of *Psilotum triquetrum* are associated with discontinuous apical activity, while instances cited of vascular tissue differentiation in experimentally induced buds on fern rhizomes, in the protocorms of Lycopods and their attached leaves, and in certain regenerative growth processes which have been described in *Lycopodium Selago*, all clearly point to the fact that where the apical growth is not actively maintained, stelar tissue is not differentiated.

The application of experimental methods to the problem of the relation of leaf development to stelar morphology in ferns has yielded results of outstanding interest. These results throw new light on the factors determining the form of the axial stele and supply an answer to the much-debated question of the cauline versus foliar nature of the stem stele.

It was observed that in *Dryopteris Filix-mas*, immediately below the apical meristem, there is an uninterrupted ring of vascular tissue in the initial stage of differentiation, while in the earliest stages of development of the fronds the vascular supply to the young primordia shows no leaf gaps. These develop a little later, their formation being associated with mechanical stresses resulting from the enlargement of the vascular systems of the leaf bases. Experimental verification of this relationship was sought by defoliating rhizomes and destroying the young leaf primordia by needle puncturing with a micro-manipulator. The apical meristematic cone alone was left intact. The rhizomes were planted in moist peat and new leaf primordia were regularly destroyed as they developed. The suppression of leaf growth was found to lead to the failure of leaf gaps to form, and therefore to the substitution of a solenostele in place of the dictyostele characteristic of this species When new leaf primordia were allowed to develop again on treated rhizomes, the specimens showed solenostely in the treated region of the shoot, with a return to normal dictyostely in the terminal region. Similar experimentally induced solenosteles were obtained in *Onoclea sensibilis*. The development of a substantial shoot stele in both species in the absence of any associated leaf growth affords proof of the truly cauline nature of the stele.

W. A. SLEDGE.

ORGANIZATION OF RESEARCH IN THE U.S.S.R. INSTITUTE OF PHYSICAL PROBLEMS

On May 18, 1943, Prof. P. Kapitza presented a very long report at the meeting of the presidium of the U.S.S.R. Academy of Sciences in which he dealt with the organization of scientific work at the Academy of Sciences. An official translation into English of parts of the report has recently been made available in Great Britain in Bulletin, 9–10, 1943, of *VOKS*, the organ of the U.S.S.R. Society for Cultural Relations with Foreign Countries, and has been used in the preparation of the following account*.

On the basis of his experience at Cambridge, Prof. Kapitza felt that the organizational forms of scientific work accepted in the West could not be applied unchanged in the U.S.S.R. "This is principally caused by the fact that in our socialist country science occupies a special place. Of course it is well known and commonly accepted in the other countries too, that science plays a great role in the development of the culture and technology of the country. But in our country science is recognized as one of the essential mainstays of the development of culture and is accorded a leading position in the development of our technology and national economy. For this reason the organization of science in our country must have a more purposeful character than that to be found in other countries, where it is rather accidental and spontaneous. The connection between science and life must be close and more complete."

As Prof. Kapitza's Institute is so young—it is only seven or eight years old—and moreover is devoted to work, on strong magnetic fields and low temperatures, which was but little developed in the U.S.S.R. at the time, the first years were spent in forming and training the scientific personnel and staff. "The question I put before myself from the very outset was what sort of problems must an institute of the Academy of Sciences work up ? . . . I had in mind an institute of physics or . . . an institute devoted to research in the field of natural science. . . . I emphasize further that I am speaking in particular of the organization of an institute of the Academy of Sciences. What is the Academy of Sciences ? It is the Chief Headquarters of Soviet Science. In my opinion it is called upon to direct all our science ideologically, from top to bottom, along a sound channel. Each of its separate institutes must pursue the same policy, that is, aspire to wield a directing influence on science in the field in which it is working, and strive to bring it into the front ranks. For this reason, the first task which an institute of the Academy of Sciences must set itself is to study a great science." In the official translation, 'great' is used throughout, but from the definition given it would appear that the correct translation is 'pure' as distinct from applied science. 'Great' science is "the science that studies the essential phenomena necessary for the most profound knowledge of nature", but it is explained that "the task of a science is to give the necessary knowledge for transforming nature so that it can serve man in his cultural development". For this reason the choice of the fields of research of an institution is extraordinarily important, and Prof. Kapitza would choose the fields of low temperatures, the atomic nucleus and the solid state as the most important at the present time.

"Only a person with a profound creative talent and one who treats his work creatively can achieve considerable success in 'great science'. For this reason the leading group of the institute must undoubtedly be formed from a few carefully picked workers who must devote themselves wholeheartedly to scientific work with not more than twenty per cent of their time given up to social or other non-scientific activities." From the emphasis laid upon conditions that the worker must be able to stay in the laboratory and himself work there, it is clear that Prof Kapitza would not approve of what might be called 'office' research in which meetings and memoranda continually interrupt actual research work. "Only when one works in the laboratory oneself, with one's own hands, conducting experiments even the most routine parts of them,—only under these conditions can real results be achieved in science. Good work cannot be done with other people's hands. . . . I am certain, that the very moment even the greatest scientist stops working in the laboratory himself, he not only ceases to develop but, in general, ceases to be a scientist. These principles are very important, but they belong only to peace-time ; war-time forces us to act differently."

The greatest emphasis is laid upon these principles, particularly with beginners. "For this purpose I try to put their work into rather rigid organizational frames. For instance, a scientific worker must not be occupied with several subjects at one time, especially if he is at the beginning of his scientific career. When the scientific worker has grown somewhat and become more experienced, he may be able to work simultaneously on two or three subjects as a rare exception ; but he must always begin with one."

Attention is then directed to the dangers of overwork. "The next point in the organization to ensure successful work, is that the scientist must work in the laboratory a limited number of hours. Long spells of work are harmful ; it is exhausting and lowers a person's creative powers." The regime observed by the workers in the Institute for Physical Problems at Moscow is that usually all laboratory work stops at 6 p.m., after which the worker leaves for home "to ponder on his work, read, study and rest". Exceptionally, by permission of the vice-director, work may continue until 8 p.m. Night work is sanctioned only by the director when it is justified by technical necessities of the experiment.

The next problems discussed are how such an Institute can influence the development of the science of the country and can avoid becoming a closed and isolated unit, which latter would be contrary to one of the principles laid down earlier. Several means are discussed. First of all, full advantage must be taken of the privileges of an institute of the Academy of Sciences, whereby the Institute has access to "rich and modern technical equipment" and to a wide field in selecting experienced staff. The special plant for making liquid helium in quantity gives the Institute for Physical Problems exceptional possibilities for doing experiments at very low temperatures. Next, these facilities are made available to workers in other institutes. Such visits are usually arranged as follows. "The comrade who wishes to work at our institute is invited to our scientific meeting where he reports on

* A complete translation of the speech together with that of a long discussion has been made by the Science Section of the Society for Cultural Relations with the U.S.S.R., 98 Gower Street, London, W.C.1.

the experiment he proposes to conduct This is discussed and, if the proposal is of scientifically grounded interest and the author is sufficiently qualified, he is given the opportunity to do his work." Not more than two or three outside workers can be accommodated at the same time without disorganizing the main work of the Institute. So far there have been more suitable applications than could be accommodated.

These guests form a vital link with other institutes, for not only is a knowledge of the work of the Institute for Physical Problems spread by them but also the guests keep the Institute informed of what is being done elsewhere. Prof. Kapitza is no believer in isolation, as the following passage shows. "In the future similar vital contacts must be established with scientists in other countries. Scientific workers from abroad visited us during the first years of the existence of our Institute. But in recent years the political situation has grown so complicated, that though there were those who wanted to come here, our connections with foreign countries had been severed, so we can only speak of this aspect of our relations with foreign scientists in view of plans for the future. But these relations must, of course, be deemed a normal and sound condition of the work of any academic institute, because science throughout the world comprises one indivisible whole"

Another function of the Institute is to train scientific workers. Prof. Kapitza was not satisfied with the external method of selecting postgraduate students. "Only the institute itself can train its future personnel, and it must do so with great diligence, by gradually nurturing them from youth." The method of selection used for two or three years before the War gave unique opportunities to students at the University of Moscow. "Taking advantage of the fact that we possess greater amounts of liquid helium for experiments at low temperatures than the refrigerating laboratories of the whole world put together, we were in a position to set up a practicum at the institute, which is attended by every student of the Moscow University School of Physics." At first, only the best students were admitted; but later every student was allowed to do two or three experiments, using liquid helium for the study of such phenomena as supraconductivity and magnetic properties near 0° A. The best of the students, if they wished, were allowed to do more than the three experiments, and from the beginning of their third or fourth university year were in close contact with the Institute. Later they were invited to help with the research work as junior laboratory assistants. Prof. Kapitza thinks that if the scheme had not been interrupted by war, probably one out of ten or fifteen of these students, on completing their graduate work, would have proved sufficiently talented to remain on the main scientific staff of the Institute.

"This method of observing young students from the time they are at the university, the thorough and constant verification of their abilities is, in my opinion, the only correct way of selecting young scientific workers, so far. . . . As you grow older, it is only young people, only your pupils, who can save you from premature mental staleness. Of course, every pupil must know more about the field in which he is working than his teacher. And who teaches the teacher, but his pupils? Thanks to his experience the teacher supervises the general fund of the work, but he is taught by his pupils, who deepen his knowledge and extend his scope." The difficulty of making correct statements about the human being doing creative work is illustrated by Kapitza's statement that "without pupils the scientist very soon dies as a creative unit and ceases to advance". Faraday had no pupils. Rutherford told Kapitza that "it is only because of my pupils that I, too, feel so young". Prof. Kapitza ends the first section of his address with the words "as I myself am approaching old age, I feel that intercourse with youth must be the modus vivendi, safeguarding one from withering away and insuring the maintenance of courage and interest in all that is new and advanced in science. Conservatism in science is worse than premature death to a scientist; it acts as a brake on the development of science."

W. H. George.

OBITUARIES

Dr. G. D. Bengough, F.R.S.

Dr Guy Dunstan Bengough, whose name is particularly associated with research on the corrosion of metals, died in the East Sussex Hospital, St. Leonards, on January 20. He was born in 1876, the son of Major E. B. Bengough, and was educated at Malvern and at Selwyn College, Cambridge. He then studied metallurgy at the Royal School of Mines and worked for a short time at the Royal Mint, gaining experience in research under Sir William Roberts-Austen. He went to Burma for practical experience in the extraction of gold and tin ores, and then held teaching posts in the Universities of Birmingham and Liverpool.

While at Liverpool, Bengough published papers on the rupture of metals at high temperatures, in which he showed that the normal fracture through the crystals of a metal gave place to one passing between the crystal grains when a certain critical temperature was exceeded. This he attributed to the presence between the grains of a non-crystalline layer, having some of the properties of a glass, being rigid at low and viscous at high temperatures. The same idea was suggested independently by Dr. Rosenhain, and this conception of an 'amorphous intercrystalline cement', although questioned by some, became popular, and long served as a basis for research.

It was while at Liverpool that Bengough began work on the corrosion of metals, especially brass marine condenser tubes, for the Institute of Metals. A series of reports was issued, in which the conditions determining general corrosion and pitting were examined, and new experimental methods were devised. The work was interrupted by the War of 1914–18. Bengough obtained a commission in the Royal Artillery, and in 1916 was captain and adjutant. He was, however, seconded for work for the Admiralty and later for the Royal Flying Corps, and continued work on corrosion in the Royal School of Mines. He later became a principal scientific officer in the Chemical Research Laboratory at Teddington, and from then onwards devoted himself to the investigation of corrosion, giving special attention to the design of apparatus.

In 1926 Bengough devised the method of anodic protection of aluminium and its alloys which proved of very great industrial value. Not only did the film produced by his method give a high degree of resistance to corrosion, but also it could be given a definite degree of porosity, so that the surface could be made to take dyes or pigments, opening up a wide field of

decorative work. He was also responsible for a method of protecting magnesium and its alloys by depositing selenium, which, however, had certain practical disadvantages.

Much of Bengough's later work was done for the Joint Corrosion Committee of the Iron and Steel Industrial Research Council and the Iron and Steel Institute, and after retiring from Teddington in 1936, he continued to act as consultant to that body and to the Department of Scientific and Industrial Research, being chairman of the Marine Corrosion Sub-Committee.

Bengough's work was marked by a high standard of accuracy. He devised methods by which extraneous factors were so far as possible excluded, so that the results were reproducible. By using carefully designed apparatus, he determined the course of the corrosion process by measuring the absorption of oxygen and when necessary the evolution of hydrogen, so that characteristic corrosion-time curves could be drawn Such carefully selected conditions cannot, of course, reproduce those of attack on a ship's plate or a condenser tube, and the relations between laboratory results and practical experience have been the subject of much controversy. Bengough laid most stress on the properties of the products of corrosion in determining its subsequent course, whereas Dr. U. R. Evans and his collaborators attached chief importance to the principle of differential aeration. The two investigators were approaching the problem from different angles, and their views were less irreconcilable than they had seemed at first, so that in 1938 a joint statement was issued which showed how great was the measure of agreement. A series of six papers by Bengough and his colleagues in the *Proceedings of the Royal Society*, of which he was elected a fellow in 1938, contains an account of a long series of quantitative experiments on corrosion. Other laboratory work is described in the reports of the Corrosion Committee published by the Iron and Steel Institute, and here his chief service was that of laying down the conditions which must be observed in making standard tests of corrodibility.

Tall and military in appearance and seemingly robust, Bengough had long periods of serious illness before that which led to his death. He was a good chairman and always showed good temper and courtesy in dealing with a notoriously controversial subject.

Dr. Bengough married Constance Helen, daughter of Lieut.-Colonel Jelf-Sharp, who survives him.

C. H. DESCH.

Prof. V. I. Vernadsky

PROF. VLADIMIR IVANOVICH VERNADSKY, one of the leading mineralogists and geochemists in the U.S.S.R., died on January 6. He was born at St. Petersburg on March 12 (February 28, Old Style), 1863. After graduating at the University of St. Petersburg in 1886, he spent some time in Paris working in the laboratories of Le Chatelier and Curie, and in 1896 was appointed professor of mineralogy at the University of Moscow. In 1906 he was elected a member of the Russian Academy of Sciences.

Prof. Vernadsky's early work was devoted to a chemical study of alumino-silicates, a subject which he later expanded and applied in a wider field of the structure of silicates and especially of kaolinite, feldspars and chlorites. At the same time he was working on descriptive mineralogy and he described and named a number of new minerals. In his lectures at the University he began to break new ground by stressing the genetic aspect in mineralogy. This genetic approach to mineralogy was fully developed in his books: "Essay on Descriptive Mineralogy" (1908, 1910) and "History of Minerals of the Earth's Crust" (1925, 1933). Eventually genetic mineralogy overstepped its proper boundaries and became merged in the far wider field of geochemistry. Thus Vernadsky may be considered the founder of the new Russian school of geochemistry, which has made such gigantic strides during the last three decades.

The greater part of Vernadsky's work on geochemistry appeared in the form of numerous papers, but a good presentation of it may be found in his book "La geochimie", published in French in 1924. It is a most stimulating book, full of daring ideas and wide generalizations. But even more daring is his book "La biosphere", published in 1929, in which he made an attempt to incorporate biological processes into his general scheme of geochemistry.

Endowed with a versatile genius and full of tremendous energy and enthusiasm, Vernadsky spread his activities far and wide. He organized regular research in mineralogy and geochemistry, helped to establish the Mineralogical Museum in Moscow, promoted the establishment of numerous scientific institutions—such as the Biogeochemical Laboratory, the Radium Institute, a permanent committee for the study of meteorites, and others. He was also the founder and the first president of the Ukrainian Academy of Sciences. Vernadsky was well known outside the U.S.S.R. Since 1920 he spent some years in Paris and Prague working and lecturing. He was a member of the Paris Academy of Sciences and the Czechoslovak Academy. He visited Great Britain in 1923, when he took part in the meeting of the British Association in Liverpool.

Vernadsky's direct contributions to science are considerable, but they are dwarfed by the greater importance of his influence on the development of new ideas in geochemistry and mineralogy. As a teacher he was most stimulating. He could easily divert the wealth of his erudition into fresh channels and mark out new lines of research. He was greatly admired and loved by his pupils and colleagues, even by those who violently opposed his views.

A bibliography of Vernadsky's works up to 1936 was given in the 'Vernadsky Jubilee Volume' published by the Academy of Sciences of the U.S.S.R., two articles in *Bull. Acad. Sci. URSS.*, Géol. Sér., No. 1 (1944), one by D. P. Grigoryev (p. 25) and the other by V. G. Kryzhanovsky (p. 35) give an account of his work, and a short account of the development of geochemistry in the U.S.S.R. has appeared in *Nature* (**154**, 814 ; 1944).

S. I. TOMKEIEFF.

WE regret to announce the following deaths:

LORD DAWSON OF PENN, P.C., G.C.V.O., K.C.B., president during 1931–38 of the Royal College of Physicians, on March 7, aged seventy-nine.

Prof. F. W. Eurich, emeritus professor of forensic medicine in the University of Leeds, known for his work on anthrax, on February 16, aged seventy-seven.

Sir Duncan Wilson, C.V.O., C.B.E., until 1940 chief inspector of factories (Home Office), and secretary during 1918–30 of the Industrial Health Research Board, on March 1, aged sixty-nine.

NEWS and VIEWS

Royal Scottish Museum, Edinburgh: Mr. Thomas Rowatt, O.B.E.

ON reaching the age limit, Mr. Thomas Rowatt has recently retired from the directorship of the Royal Scottish Museum, which he has held since 1934. He entered the Civil Service as assistant in the Technological Department of the Royal Scottish Museum in 1902, became assistant-keeper in 1909 and keeper of the Department in 1921. The period of his directorship marked steady progress in the development of the activities of the Museum, and although the building was closed to the public on the outbreak of the War, and its valuable collections were dispersed to places of safety, Mr. Rowatt has in recent years arranged for special exhibits which have proved attractive to the people of Edinburgh and to the city's many visitors from overseas Perhaps the most popular of these has been the present Fisheries Exhibition, arranged in co-operation with the Fisheries Department of the Scottish Home Office, at which the comprehensive collection of exhibits illustrating many aspects of Scottish fisheries has been supplemented by weekly lectures on a wide variety of fishery topics by recognized experts.

Dr. Douglas A. Allan

MR. ROWATT has been succeeded in the directorship by Dr. Douglas A. Allan, formerly director of the Liverpool Public Museums. Dr. Allan is a graduate of the University of Edinburgh, where he specialized in geology, taking part in the late Dr. W. S. Bruce's expeditions to Spitsbergen, and acting as assistant in the University Department of Geology under the late Prof. T. J. John. During 1925–29 he was lecturer in geology in Armstrong College, University of Durham, and in the latter year was appointed director of the Liverpool Museums. Dr Allan has taken an active part in the promotion of museum interests as chairman of the Museums Association and as a member of the Post-War Reconstruction Committee on Museums and Art Galleries. Last year he was awarded the Neill Gold Medal of the Royal Society of Edinburgh for his researches on the geology of the Highland border in Angus and Perthshire.

Biologist to North of Scotland Hydro-Electric Board

AN appointment of more than usual interest to naturalists has been announced by the North of Scotland Hydro-Electric Board, the authority for the development of water-power schemes over a considerable area of the most attractive scenery in Scotland. In 1943 the Board appointed Mr. W. L. Calderwood, formerly inspector of Scottish salmon fisheries, as its principal consulting adviser on fishery matters, and he will continue in that capacity; but a full-time fishery adviser and biologist, Dr. John Berry, has now been appointed to ensure that in the planning of new schemes due attention will be given to all aspects which affect wild life. Dr. Berry's wide interests in natural history fit him well for such a post. For some time he was director of the Freshwater Fisheries Research Station at University College, Southampton, and before the War he carried out salmon research for the Fishery Board for Scotland and the Moray Firth Salmon Fishery Company. In 1939 he published for the International Wildfowl Inquiry an exhaustive volume on "The Status and Distribution of Wild Geese and Wild Duck in Scotland". During the War he has been officer-in-charge of Press censorship in Scotland, but naturalists will welcome his return to his proper vocation

Royal Society of Edinburgh

Awards

THE Council of the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize, for the period 1940–44, to Prof. H. W. Turnbull, University of St Andrews, for his distinguished contributions to mathematical science and the history of mathematics, and the Makdougall-Brisbane Prize, for the period 1942–44, jointly to Prof. Max Born and Dr. H W. Peng, University of Edinburgh, for their papers on "Quantum Mechanics of Fields" published in the *Proceedings* of the Society within the period of the award

New Fellows

THE following have been elected ordinary fellows of the Royal Society of Edinburgh: Dr Robert Aitken, lecturer in dermatology, University of Edinburgh, Prof C. H Browning, professor of bacteriology, University of Glasgow; Mr A. M. Bryan, mining engineer; Dr. William Burns, agricultural commissioner with the Government of India (retired); Dr. L. B. C. Cunningham, superintendent of the Air Warfare Analysis Section, Ministry of Aircraft Production; Prof. A. Durward, professor of anatomy, University of Leeds; Dr. A. Erdélyi, lecturer in the Department of Mathematics, University of Edinburgh; Dr. A. Ghaffar, lecturer in physiology, Robertson Medical School, Nagpur; Dr. W. Spence Haldane, teacher of chemistry, Dunfermline High School, Mr. E H E. Havelock, secretary of the Development Commission; Dr. R. E. Illingworth, lecturer on chemistry, School of Medicine, Royal Colleges; Dr. John Jardine, principal assistant secretary, Scottish Education Department; Dr. D. D. Logan, medical practitioner, Woodside, Lanarkshire; Mr. I. S Macadam, secretary of the Royal Institute of International Affairs; Dr. D. M. McIntosh, director of education for the County of Fife; Mr. H. P. Morrison, publisher; Prof. J. T. Randall, professor of natural philosophy, University of St. Andrews; Dr. James Stirling, lecturer in plant physiology, University of Liverpool, Mr. Meirion Thomas, reader in plant physiology, King's College, University of Durham; Dr. Robert Walmsley, senior lecturer in anatomy, University of Edinburgh; Prof. S. J. Watson, Department of Agriculture, University of Edinburgh, and principal, Edinburgh and East of Scotland College of Agriculture; Mr. James Wilkie, secretary of the Carnegie United Kingdom Trust; Mr. D. C. Wilson, director of T. and H. Smith, Ltd., Corstorphine; Dr. N. C. Wright, director of the Hannah Dairy Research Institute, Ayr; Prof. C. M. Yonge, regius professor of zoology, University of Glasgow.

New Aeronautical Research Establishment

SIR STAFFORD CRIPPS, Minister of Aircraft Production, in reply to a question in Parliament, has stated that it is proposed to build a new research and development centre for both civil and military aircraft construction at Bedford. Many new problems have now to be faced with the approach of supersonic speeds, which will need much special apparatus and

up-to-date wind tunnels. It is intended to make a beginning as soon as possible; but the rate at which the equipment will be provided will naturally depend upon the finance available to meet what will inevitably be a costly project. The transfer of both apparatus and staff from the present Royal Aircraft Establishment at Farnborough will be gradual. Farnborough will eventually be retained for special research and development on armament, instruments and such auxiliary services. It is understood that the new centre will not affect the R.A F. station at Cardington, but will be an extension of a present American bomber station and the Bedford airport at Thurleigh.

The adoption of this scheme completes plans that have been under discussion for a long time in the aeronautical world, and is perhaps the widest organization of industrial applied science ever attempted in Great Britain. The experimentation relative to the immediate progress in aircraft design and the solving of problems arising upon aircraft in use will be the province of the designing and constructing firms. At the Royal Aircraft Establishment the Air Ministry, as purchasers and users of aircraft for the Fighting Forces and possibly to a certain extent for air transport, will deal with their special problems, many of which must be handled in this way as necessarily they will be secret. The new organization will deal with long-range fundamental research of a general nature, that will add to the knowledge of all who use the science of aeronautics in any way. This should extend the usefulness of the Aeronautical Research Committee, a body which, acting in an advisory capacity, has been largely dependent upon the goodwill and the capacity of the industry, Government establishments, and the universities, for the carrying out of its suggestions. The importance of this is obvious, and it is hoped that its development will be able to proceed at a reasonably rapid rate.

Royal Commission for the Exhibition of 1851

AT the 148th meeting of the Commissioners of the Exhibition of 1851, held on May 6, the Princess Royal was elected president of the Royal Commission in succession to the late Duke of Kent. In his survey of the work of the Board of Management during the period immediately before and after the outbreak of war, Lord Macmillan gave reasons for the partial suspension of the scholarship schemes in 1939, when no fresh awards were made although existing scholarships were continued until their holders were absorbed in the national war effort. So great was the demand for the Commission's experienced research workers and engineering students that by the end of 1940 practically all these men and women had relinquished their awards to take up appointments in the technical branches of the services or in special work for the war industries. Referring to the scientific research awards of the Commission, Lord Macmillan emphasized that the scholarship scheme has produced many of the most eminent men of science in academic, industrial and professional life, including sixty-six fellows of the Royal Society and no less than six Nobel laureates. The Commission's industrial bursary scheme has also been very successful and has helped to place in industry more than six hundred graduates who could not depend on their parents for financial support after their university scholarships came to an end. Sir Robert Robinson described the work of the Science Scholarships Committee. Since 1922, when the earlier scheme was revised, 90 senior students and 149 overseas scholars from the Dominions have been appointed. The value of the material derived from the Dominions has been more than gratifying. Their records as a whole show that they are using the knowledge and experience gained as scholars to very great advantage in the scientific service of the Commonwealth.

Coasts of England and Wales

A SURVEY of the scenic qualities of the coasts of England and Wales has been made by Mr. J. A. Steers at the instance of the Ministry of Town and Country Planning. The results are embodied in a map accompanying a paper in the *Geographical Journal* of July–August 1944. The greater part of the coastal scenery is classified as of good or very good quality, with exceptional quality mainly in parts of Wales and Cornwall. Comparatively little, outside certain industrial areas, has been ruined; but Mr. Steers notes the frequent occurrence of bad scattered development marked by huts and bungalows on parts of the East Anglian coast and elsewhere, including, no doubt, coasts in the south-east, an area for the time excluded from the survey. Only a few stretches of coast-line up to the present are under the National Trust, and it is evident that steps will need to be taken speedily, not only to check undesirable building, but also to ensure access to the coast-line. Nor must the coast-line be considered in any rigid conception: in many parts it is a zone, and not a coast, that must be protected. Mr. Steers argues that the many problems relating to the maintenance of our coast-line from both a scenic and also a physical point of view should be the work of a national organization.

Individual Welfare and Human Progress

THE R.A.F. Penrose Memorial Lecture delivered by the Right Hon. H. B. Butler, British Minister at Washington, has been published (*Proc. Amer. Phil. Soc*, 88, 151; 1944). Mr. Butler discusses the lessons derived from the work of the International Labour Organisation during the last twenty-five years. Its organization, he says, has needed little amendment during its first twenty-five years. It was founded in the belief that the welfare of the common man must be one of the main objectives of human society, the supreme aim of which is individual progress. There can be no peace without social justice; nor can we have social justice without peace. War must go; but economic upheaval must also be prevented. The great slump of 1929–32, which was due, not to inability to produce, but to lack of purchasing power, is likely to recur after the present War, to a more serious degree. That slump taught us that international economic unity is essential. Nations must act together to prevent a repetition of it. Wise planning is not enough. There must be a true conception of life as well. The Fascist danger, spread far and wide, will still be a menace after the War, and it will be one of the tasks of the International Labour Organisation, which has been repudiated by all the Fascist States, to fight it. If we follow purely egoistic and materialistic aims and ignore the good of our neighbours, putting economic above spiritual values, we shall inevitably decline. The cynicism of despair will be equally fatal. But

if we believe that humanity, by its own exertions, can attain a higher and nobler destiny than any it has yet known, then we shall not fail.

Overhead Lines and Outdoor Equipment on A.C. Systems

IN a paper read recently in London before the Institution of Electrical Engineers, R. C. Hatton and J McCombe lay down the guiding principles that for the efficient operation, maintenance and testing of electrical equipment in complex A.C. systems, it is of fundamental importance to provide adequate transport and communication systems, a carefully selected and trained staff at strategic points, and centralized control of all operations, and to enforce the strict observance of a suitable code of safety regulations. The maintenance of the various components of overhead lines and outdoor sub-stations, which the authors' experience has shown to be necessary or desirable, is detailed, and suitable intervals for such maintenance work are indicated. An analysis of faults is made for both the overhead lines and transformers on the system, and the steps are described which have been taken, or which should be taken, for counteracting them. The predominance of faults due to lightning is emphasized and the precautions which can be taken are discussed. Finally, the authors indicate the developments they consider to be desirable to minimize maintenance costs and at the same time to improve the reliability of electricity distribution, with special reference to the system of the Yorkshire Electric Power Co.

Institution of Electrical Engineers: Scholarships for 1945

THE Council of the Institution of Electrical Engineers will this year consider the award of three research scholarships and grants, and seven scholarships for undergraduates and students to attend universities and technical colleges. These awards will be made subject to the regulations laid down by the Ministry of Labour and National Service regarding the candidates' ages at the commencement of their courses. *Research Scholarships:* Ferranti Scholarship, £250 per annum for two years; Swan Memorial Scholarship, £120 for one year; War Thanksgiving Education and Research Fund, grants up to £100 for one year. *Student Scholarships*: Duddell Scholarship, £150 per annum for three years; William Beedie Esson Scholarship, £120 per annum for two years, renewable in approved cases for a third year; Silvanus Thompson Scholarship, £100 per annum, plus tuition fees for two years; David Hughes Scholarship, £100 for one year; Salomons Scholarship, £100 for one year; Paul Scholarship, £50 per annum for two years; Thorrowgood Scholarship, £25 per annum for two years. Full particulars can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. The closing date for receiving applications is April 15, 1945, and the awards will be made towards the end of June.

Conference on X-Ray Diffraction Analysis

THE X-ray Analysis Group of the Institute of Physics will hold a conference during April 12 and 13, at the Royal Institution, London, under the chairmanship of Sir Lawrence Bragg. The programme includes a lecture by Prof. J. D. Bernal on "The Future of X-ray Analysis", and a series of papers on new and improved methods. Discussions are to be included on the equipment of a laboratory for X-ray analysis, the interpretation of X-ray diffraction by optical principles, and the proposal to convert X-ray wave-lengths to absolute values Further particulars may be obtained from the honorary secretary of the Group, Dr. H Lipson, Crystallographic Laboratory, Free School Lane, Cambridge.

Care of Laboratory Animals

THE Universities Federation for Animal Welfare (UFAW), 284 Regent's Park Road, Finchley, London, N.3, has been collecting information for a handbook on the care of laboratory animals. Major C. W. Hume and Dr. F. Jean Vinter state that they still require information about maintaining healthy stocks of the larger species—cats, dogs, the smaller ungulates and primates. These species will not be dealt with in detail in the handbook, but references will be given to published accounts of methods of maintaining healthy and contented stocks and a list provided of laboratories at which advice on the subject can be given at first-hand.

Announcements

THE Senatus of the University of Edinburgh has awarded Cameron Prizes for 1945 "for a highly important and valuable addition to Practical Therapeutics" to Sir Alexander Fleming in recognition of his discovery of penicillin, and to Sir Howard Florey in recognition of his work in making possible the clinical application of penicillin.

THE title of professor of chemical pathology in the University of London has been conferred on Dr. E. J. King, in respect of the post held by him at the British Postgraduate Medical School.

PROF. DOUGLAS HAY, honorary professor of mining in the University of Sheffield, has been appointed a member of the Board for Mining Examinations in succession to the late Mr. Robert Clive.

THE trustees of the Miners' Welfare National Scholarship Scheme, established by the Miners' Welfare Commission for the provision of university scholarships for workers in or about coal mines and their sons and daughters, have appointed Prof. J. F. Duff, vice-chancellor of the University of Durham, to be chairman of the Selection Committee in succession to Sir Franklin Sibly; and Prof. W. E. Curtis, professor of physics at King's College, Newcastle-upon-Tyne, to be a member of the Committee in succession to Prof. A. M. Tyndall.

THE Royal Society of South Africa elected the following to fellowship during 1944: Dr. R. A. Dyer, chief of the Division of Botany and Plant Pathology, Pretoria, well known for work on the Euphorbias; Dr. N. Sapeika, assistant professor of pharmacology, University of Cape Town, and author of "Actions and Uses of Drugs"; and L. H. Wells, lecturer in anatomy, University of the Witwatersrand, and anthropologist.

ERRATUM. In *Nature* of February 24, p. 233, Prof. Sydney Chapman was wrongly described as "chief professor of mathematics, University of London". Prof. Chapman is chief professor of mathematics in the Imperial College of Science and Technology, University of London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Vitamin A

An earlier publication[1] presented evidence which indicated that fish liver oils contain a substance (or substances) which has vitamin A activity but differs in properties from the vitamin A (here designated A_1) previously obtained in crystalline form[2]. Subsequent research has revealed that the newly recognized compound occurs in fish liver oils in substantial amounts, being responsible for approximately one third of their total vitamin A potency.

We have succeeded in isolating the vitamer* from fish liver oils in pure form. It crystallizes as light yellow needles (m.p. 59–60°) which contrast with the yellow prisms (m.p. 62–64°) of vitamin A_1. It has an absorption maximum at 328 mμ ($E^{1\text{ per cent}}_{1\text{ cm}} = 1675$) while vitamin A_1 has its absorption maximum at 325 mμ ($E^{1\text{ per cent}}_{1\text{ cm}} = 1750$). It is an alcohol which forms a red anthraquinone carboxylate (m.p. 130–131°), while vitamin A_1 yields a corresponding ester which is yellow (m.p. 123–124°). By treatment with alcoholic hydrochloric acid it forms the same anhydro compound (m.p. 76–77°)[3] as vitamin A_1, but the reaction proceeds much more slowly. It is more stable to atmospheric oxidation than vitamin A_1.

The constitution of the new vitamer has not yet been definitely established. The available evidence, however, suggests that it may be a geometrical isomer of vitamin A_1 differing in the *cis-trans* configuration at the double bond nearest the hydroxyl group.

A method has been developed for estimating the percentage of the new substance in fish liver oils and concentrates. This is based on the observation that maleic anhydride reacts more slowly with it in benzene solution than with vitamin A_1. Analyses of samples of soupfin shark and dogfish liver oil showed that 30 per cent and 33 per cent, respectively, of the vitamin A was the newly recognized compound.

A second method of estimation of the vitamer depends on the fact that it forms the anhydro compound on treatment with alcoholic hydrochloric acid much more slowly than vitamin A_1. The procedure is less useful than the one just described because it must be carried out on the saponified fish liver oil or concentrate.

A preliminary bio-assay on the new compound has indicated that its potency is nearly the same in kind and magnitude as that of vitamin A_1. More extensive assays are in progress.

The recognition that the vitamin A activity of fish liver oils is due to at least two different substances emphasizes the need for an improved system of nomenclature. The term 'axerophthol' proposed by Karrer for vitamin A_1 has not gained general usage and moreover establishes no basis for naming newly discovered vitamers. The use of subscripts is also unsatisfactory. For example, while the vitamin A_2 found in the liver oils from freshwater fish possesses curative powers for the vitamin A-deficiency syndrome, it probably has a basically different structural formula than vitamin A_1.

We have consulted various authorities in the United States and have suggested that the A-vitamins in fish liver oils be named from the genus of fish in which they were first found or in which they occur in concentrated form. Suggested terms were 'gadol' for vitamin A_1 from *Gadus*, the cod; and 'galol' for the new vitamer from *Galidæ*, the shark If other A vitamins are discovered in the future they could be named readily by this system, which is now being considered by the Committee on Biochemical Nomenclature of the U.S. National Research Council.

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* The word 'vitamer' was introduced simultaneously by Dean Burke and associates of the National Cancer Institute and workers at Distillation Products, Inc., to indicate two or more substances which have the same ability to cure a single deficiency syndrome.

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Antibiotic Action of an *Aspergillus* Strain against *Mycobacterium tuberculosis**

In the course of investigations on the growth conditions of *Mycobacterium tuberculosis*[1], we have observed that contamination by an *Aspergillus* strain of cultures of *M. tuberculosis* human and bovine type resulted in a distinct inhibition of growth. Systematic experiments founded on this observation led to the preparation of filtrates from pure cultures of the mould, which were active against *M. tuberculosis* human and bovine type. A preliminary report of our results was presented to the Swedish National Society against Tuberculosis on October 1, 1943. In view of a recent communication by M. A. Soltys[2], we wish to report briefly our findings.

Our *Aspergillus* strain (the identification of which is not yet completed), when grown on a synthetic medium containing iron-, sodium- and magnesium-salts, glycerine and certain nitrogenous substances, such as asparagine, at pH 7·2 (phosphate buffer) and at 37° C., produces an antibiotic, which inhibits the growth of *M. tuberculosis* and of *Staphylococcus aureus*. No antibiotic is produced, when the mould is grown on a Czapek-Dox medium. Soltys states that his 'aspergillin' is inactive against *Staphylococcus aureus*; thus, the antibiotic present in our culture filtrates may be different from 'aspergillin'. The chemical properties so far investigated point to the non-identity of our product with the known antibiotics isolated from aspergillus cultures, such as glyotoxin, helvolic acid or patulin. A detailed account of these investigations will be published elsewhere.

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Inhibition of Mould Growth by p-Aminobenzoic Acid and the n-Butyl Ester

IN tests conducted in these laboratories, p-aminobenzoic acid and the n-butyl p-aminobenzoate have shown definite reduction in rate of growth of three representative moulds (species of *Aspergillus*, *Penicillium* and *Byssochlamys*) growing on Czapek-Dox agar medium, pH 4. Inhibition in the case of the free acid was very marked (at least 50 per cent) at a concentration of 5·6 millimolar (mm.) and a reduction could still be detected, in the case of *Aspergillus*, as low as 0·18 mm The butyl ester proved more effective, greater than 70 per cent reduction being observed at 1 0 mm. and a marked effect persisting as low as 0·14 mm.—the lowest concentration tested. In cases of the intermediate and lower concentrations of the free acid, the colonies remained regular in outline and maintained a steady though reduced rate of increase; concentrations 9·8 and 5 6 mm gave rise to very irregular and fluctuating growth. With the higher concentrations of both substances, particularly of the p-aminobenzoic acid, an orange-yellow pigmentation was observed both in the mycelial felt and in the surrounding medium[1,2].

With interest largely focused on the anti-sulphonamide and growth-factor effects of p-aminobenzoic acid and the fact that these are shown at extreme dilutions, it is not surprising that observations of inhibition by this substance have been relatively few. Woods[3] has actually referred to a slight inhibition of bacteria at concentrations (unspecified) above 0·2 mm. Most workers have been concerned with lower maximum concentrations than this, although Mayer[2] does not report inhibition of *Mycobacterium tuberculosis* when working at concentrations as high as 7·3 mm. Tamura[4] has, however, found inhibition with *Bacterium tularense* at 0 5 mm. and complete absence of growth after eight days at 1·0 mm. Johnson *et al.*[5] found evidence of both stimulation and inhibition of luminescent bacteria according to the concentration of p-aminobenzoic acid in the different parts of the treated growth. Lee and Foley[6] have made the interesting observation that raised temperatures can cause inhibition of bacterial growth by p-aminobenzoic acid at concentrations as low as 0 01 mm., as well as failure to show anti-sulphonamide action. Lavor and Ferguson[7] record harmful effects on protozoa by concentrations of p-aminobenzoic acid (7·3–0·073 mm.), comparable with those reported above as effective against moulds.

Esters of p-aminobenzoic acid have also been regarded principally from the point of view of growth factor and anti-sulphonamide activity. These include simple alkyl esters[3,8,9] and local anæsthetics of the procaine type[10,11,12]. Kuhn *et al.*[9] include some results with such esters. Their experience of the butyl ester differs from ours with fungi, in that they report it, together with the ethyl, lauryl and cetyl esters, as having no bacteriostatic effect with *Streptobacterium plantarum* when studied up to approximately 12 mm. (This would, according to our experience, be greatly in excess of the solubility of the butyl ester.)

Other compounds related to p-aminobenzoic acid should be mentioned. Both Hirsch[13] and Kuhn *et al.*[9] have reported inhibition by p-aminobenzamide; the former found it almost as active as sulphanilamide at comparable concentrations, the latter noted growth accelerations at greater dilutions (0·007 mm.) but 50 per cent inhibition at 0·014 mm. Auhagen[14] reports relatively weak sulphonamide-like inhibition with p-aminoacetophenone and p-aminobenzophenone. Other workers[15,16] have studied a number of substituted p-aminobenzoic acids, and have found that according to the nature and position of the substituents, some of the compounds demonstrated sulphonamide-like bacteriostasis, some retained p-aminobenzoic acid properties, while others were practically inactive.

Such results as those reviewed above, taken with our own experience with moulds, suggest that more attention might be given to the inhibitory action of p-aminobenzoic acid and its derivatives. On one hand, increasing the concentration of p-aminobenzoic acid gives rise to definite inhibition. On the other, stimulation by sulphanilamide has been observed in low enough concentrations[5,17]. Compounds like sulphanilamide and p-aminobenzoic acid might profitably be regarded as members of the same broad biochemical group possessing a similar 'pattern' of inhibitory properties: showing quantitative rather than qualitative differences in their toxic behaviour.

Evidence of its toxic properties raises the question as to the form in which p-aminobenzoic acid is likely to occur in the cell. It seems probable that some at least is built into a larger 'non-toxic' molecule. Recently the existence of 'bound' forms of p-aminobenzoic acid in naturally occurring material has been postulated [18,19,20]. According to Blanchard's evidence[20] the amino group is likely to be involved in a peptide link. Ratner and others are reported[21] as having isolated from yeast a polypeptide containing one molecule of p-aminobenzoic acid and some thirteen molecules of l-(+) glutamic acid.

Further systematic investigations of p-aminobenzoic acid and related compounds are being conducted in these laboratories.

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Production of Kojic Acid by *Aspergillus effusus* Tiraboschi

IN 1942 Wilkins and Harris[1] reported that culture media on which the mould *Aspergillus effusus* Tiraboschi (National Collection of Type Cultures, No. 973) had grown inhibited the growth of *B. coli* and *Staph. aureus*. It has been found that, under cultural conditions to be described, the whole of the antibacterial activity can be attributed to the production of kojic acid. Owing to the weakness of its antibacterial properties this substance is not generally regarded as an antibiotic; its detection as such was due to its relatively high concentration in the culture fluid. Attention is directed here to kojic acid as an antibiotic because it is a common product of mould metabolism and may account for the inhibitory properties of a number of moulds not yet investigated in detail. Recognition of this possibility may prove time-saving to other workers.

Kojic acid is stated by Yabuta[2] to be produced in a high yield from various carbohydrate sources by *Aspergillus oryzæ*, *albus*, *candidus* and *nidulans*. It was obtained by Birkinshaw *et al.*[3] from *Aspergillus parasiticus* and *Penicillium daleæ* Zaleski. The latter authors deduced its production also by *A. effusus* Tiraboschi, *A. tamarii* and *A. flavus* from the production of a strong wine-red colour on treating the crude medium with ferric chloride; but it should be noted that the mould products claviformin (produced by at least four fungal species) and aspergillic acid give a similar red colour with ferric chloride. The literature of kojic acid, up to 1934, has been reviewed by Barham and Smits[4], who mention its antibacterial properties.

The mould was grown at 24° C. in Erlenmeyer flasks on a medium of the following composition: maltose 40 gm., peptone 10 gm., malt extract 26 c.c., water 1 litre. The antibacterial activity of the medium, measured by the plate and cylinder method against *Staph. aureus*, reached a maximum at 12–14 days, thereafter diminishing rapidly. At that time yields of kojic acid averaged 8–9 gm. per litre.

Tested by the dilution method, kojic acid completely inhibited the growth of a strain of the following bacteria at the concentration shown:

$> 1:400 < 1:800$ *Proteus, Salm enteritidis, Bact. coli.*
$> 1:800 < 1:1600$ *Salm. typhi, Staph pyogenes.*
$> 1:1600 < 1:3200$ *Ps. pyocyanea* (2 strains).
$> 1:3200 < 1:6400$ *Ps. pyocyanea* (2 strains).

Unlike that of many other antibacterial substances, its potency was little affected by the number of bacteria present. A thousandfold increase in the size of the inoculum made little or no alteration in the inhibitory titre. Neither was the antibacterial activity reduced after incubation for three hours at 37° C. in 50 per cent serum.

For testing toxicity to animal tissues, solutions of kojic acid were neutralized with sodium hydroxide to *p*H 6·8 (which does not diminish the antibacterial activity of the solution). The toxicity to cells *in vitro* was estimated by its effect on human leucocytes[5]. In a 1:100 solution the cells became sluggish or stationary in half an hour and were nearly all dead in three hours. In 1:200 the movement of the majority was arrested in two hours but the cells did not die. The preparation in 1:400 did not differ significantly from control preparations. Dr. R. W. Ross informs us that a 1:400 solution did not interfere with phagocytosis by human leucocytes.

Sodium kojate produced characteristic signs when injected into mice by any route in a sufficiently large dose. The mouse became prostrate, the legs and tail stretched out stiffly and the breathing slow and laboured; the coat was not roughened. After the largest doses there was slight irregular twitching of muscle groups and a lethal dose produced convulsions before death. The duration of sickness was proportional to the size of the dose, and even after prostration lasting for two or three hours, recovery, if it occurred, was rapid and complete.

Friedemann[6] described similar effects on dogs, rabbits and rats, and gave the toxic dose (intravenous) as 150 mgm. per kgm and the lethal dose as 1 gm. per kgm. The figures for mice are of the same order. In mice weighing from 20 to 23 gm., 5 mgm. injected subcutaneously, intraperitoneally or intravenously usually produced signs of toxicity, and 30–40 mgm. killed, by mouth 20 mgm. was without effect, 40 mgm. produced illness and 80 mgm. killed.

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A Twenty-four Hour Pregnancy Test for Equines

IN 1928 the Aschheim-Zondek Test for the diagnosis of human pregnancy in urine was introduced[1]. In 1930, B. Zondek proposed a modification of this test for the diagnosis of equine pregnancy in the blood and in the urine[2]. The blood test is only feasible, however, between the 42nd and 125th days of pregnancy, after which the equine gonadotropin disappears from the blood[3].

These pregnancy tests are based upon the gonadotropic reactions which have been classified (1926–27) as follows[4]:

Anterior pituitary reaction, I.	œstrus reaction in the mouse and rat
Anterior pituitary reaction, II:	hyperæmia in the rat ovary, follicle hæmorrhage in the ovary of mouse and rabbit (blood dot)
Anterior pituitary reaction, III:	corpus luteum formation in the ovary of mouse, rat and rabbit.

Most characteristic is the follicle hæmorrhage appearing (as anterior pituitary reaction II) in the ovary of the mouse and rabbit, which has since been used for the diagnosis of pregnancy in man and equines. The reliability of pregnancy tests, based upon the gonadotropic reaction, is about 99 per cent. The only disadvantage of these tests is the long reaction time required: 6 days for the rat, 5 days for the mouse and 2 days for the rabbit.

It has recently been demonstrated that a reliable diagnosis of human pregnancy may be carried out within twenty-four hours, using the hyperæmic reaction of the infantile rat ovary (anterior pituitary reaction II). The test is based on the fact that within twenty-four hours (sometimes even two to six hours) following the injection of human pregnancy urine, the ovaries of the infantile rat undergo a strong

hyperæmic reaction, accompanied by swelling, as already described in 1927[4]. This is the earliest stage of gonadotropic reaction following the injection of gonadotropic hormone. It seemed possible that the rapid method as applied to the urine of pregnant women might be applicable as well to the blood of pregnant mares. In the latter, the diagnosis of early pregnancy by a veterinarian is difficult, and on the other hand it is important to the breeder to recognize pregnancy in its early stage in order to prevent abortion due to excessive work or strain.

The first thing to be established was whether the hyperæmia test is evoked by pregnant mare blood gonadotropin as it is by human pregnancy urine gonadotropin The clarification of this point was of importance, as pregnant mare blood contains mostly the follicle-stimulating hormone and human pregnancy urine contains chiefly the luteinizing factor. We found the hyperæmia test to be quite sensitive for the detection of minute amounts of human pregnancy urine gonadotropin, 1 hyperæmia unit (anterior pituitary reaction II) equalling 1 œstrus unit (anterior pituitary reaction I) Unfortunately, the hyperæmia test (anterior pituitary reaction II) is not so sensitive for the detection of small amounts of pregnant mare blood gonadotropin, 1 hyperæmia unit (anterior pituitary reaction II) equalling as much as 10 œstrus units (anterior pituitary reaction I) and 3 luteinization units (anterior pituitary reaction III) of pregnant mare blood gonadotropin. The new method requires, therefore, 3–10 times the amount of hormone administered in the earlier pregnancy test[2] for equines, but it has the advantage of giving clear-cut results with 99 per cent reliability within twenty-four hours. It is possible to obtain a positive reaction with the hyperæmia test as early as 4–6 hours after injection of the equine gonadotropin. The reaction at this early stage is positive, however, only in 33–50 per cent of the animals, and whereas the positive reaction indicates pregnancy, negative results cannot be evaluated. Furthermore, the faint pink colour of the ovary, obtained after 4–6 hours, is not so convincing as the dark red appearance after 12–24 hours. Therefore, we prefer the 24-hour pregnancy test.

Technique: The mare or donkey is bled from the jugular vein and 20 c.c. serum are sent to the laboratory. If the specimen is sent through the post a few drops of phenol or preferably tricresol should be added to the serum. In the laboratory four rats 3–5 weeks old, 30–40 gm. in weight are injected as follows:

R.1 2·0 c.c.
R.2 : 1·5 c.c.
R.3 : 1·0 c.c.
R.4 : 0·5 c.c.
} twice daily, preferably at 2–4 hr. intervals.

R.1 is killed on the evening of the day of the first injection at least 6 hours after the first injection and 4 hours after the second injection.

R.2 and *R*.3 are sacrificed on the following day, about 18–24 hours after the first injection.

R.4 is sacrificed 5 days after the first injection, after having received 2 × 0·5 c.c serum for 4 consecutive days, that is, a total of 4 c.c. serum.

The test is positive if at least both ovaries of one of the rats *R*.1–3 show a distinct red colour resembling that of the spleen or kidney. As a rule, all the rats react similarly. Autopsy of rat *R*.4 takes into consideration vaginal œstrus and corpus luteum formation as in the original Aschheim-Zondek test and serves for control purposes only. It detects all cases of early pregnancy or late pregnancy where the blood gonadotropin titre is lowered.

The hyperæmia test gives positive results with all sera containing more than 250 I.U. pregnant mare blood gonadotropin per litre. It may also be used for quantitative pregnant mare blood gonadotropin determinations since 1 hyperæmia unit, that is, the smallest quantity of serum evoking the rat anterior pituitary reaction II, equals about 1 I.U. It facilitates the preparation of pregnant mare blood gonadotropin by making possible the bleeding of pregnant mares at the peak of hormone production.

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A New Type of Phase Rule Solubility Test for Enzyme Purity

IN 1937 Kuhn and Desnuelle[1] prepared a highly purified specimen of Warburg's yellow enzyme, and as evidence of purity they pointed out that when ammonium sulphate was added to the solution the yellow colour and the protein began to come out of solution at the same salt concentration, and that the decrease in yellow colour and the decrease in protein content were parallel. They did not develop the test further, nor did they successfully apply it to the analysis of impure solutions.

From the work of Butler, Blatt and Southgate[2], Roche, Doriot and Samuel[3,4], and Jameson and Roberts[5], it is clear that when increasing quantities of a precipitating salt are added to a series of protein solutions, the appearance of a new solid phase will cause a break in the curve relating concentration of protein in solution to salt concentration. Further, Jameson and Roberts pointed out that such breaks in continuity were in accordance with the phase rule.

It is the object of this account to show that an analysis of the effect of increasing quantities of a precipitating salt on a protein solution can be used as a purity test for any protein with an accurately measurable specific quality.

The enzyme solution used in these studies was a highly purified solution of pig liver esterase, and the precipitating salt was ammonium sulphate. Increasing quantities of salt were added to equal volumes of enzyme solution, and after precipitation had ceased the solutions were filtered and the filtrates analysed for enzyme and for protein. The test consists in plotting these latter quantities against one another and analysing the result.

From the work of Cohn[6], we would expect a linear relationship between log solubility and ionic strength. It is therefore interesting to note that when plotted logarithmically, there is a double inflexion in the enzyme precipitation curve (graph 2), indicating the presence of two esterases the solid phases of which behave independently.

We can interpret graph 5 somewhat as follows. The fall in enzyme activity between *A* and *B* occurred before any protein precipitation took place, and is therefore probably due to denaturation on the air bubbles salted out by the ammonium sulphate. At *B*

the solution is saturated with respect to an impurity and the protein concentration decreases without any change in enzyme concentration to C, where the solution becomes saturated with respect to the enzyme. Between C and the origin the concentration of the impurity decreases with respect to that of the enzyme and the curve gradually straightens. The inflexion due to the precipitation of the second enzyme does not occur, probably because the activities of the two enzymes expressed as enzyme units per milligram of protein nitrogen are too close to show as a difference in slope.

If we assume Cohn's equation[6] and let S_I and S_E, β_I and β_E, and k_I and k_E, be the solubilities, intercept constants, and slope constants of the impurity and of the enzyme respectively, and if I be the ionic strength, we have:

$$\log S_I = \beta_I - k_I I \quad . . . . (1)$$

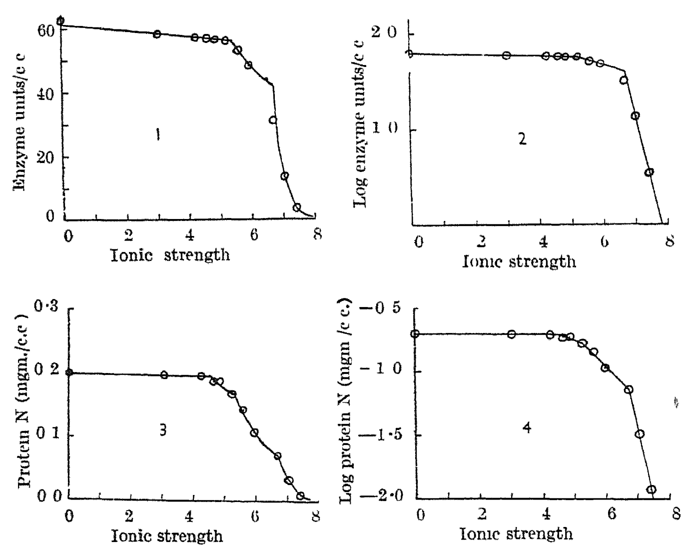
$$\text{and} \log S_E = \beta_E - k_E I \quad . . . . (2)$$

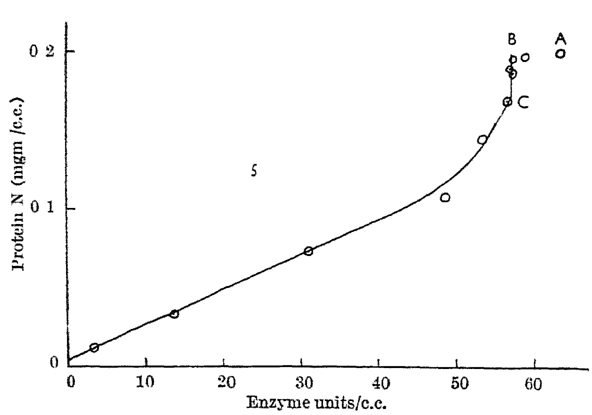
$$\therefore \quad S_I = e^{(\beta_I - k_I I)} \quad . . . . (3)$$

$$\text{and} \quad S_E = e^{(\beta_E - k_E I)} \quad . . . . (4)$$

Now since the protein concentration P at any point on graph 5 between C and the origin is equal to the sum of the protein solubilities, the equation to graph 5 must be:

$$P = e^{(\beta_I - k_I I)} + \frac{1}{K_E} e^{(\beta_E - \beta_E I)} \quad , \quad . \quad . \quad (5)$$





where the conversion constant K_E is equal to the activity of the pure enzyme expressed as enzyme units per milligram of protein nitrogen.

Equation 5 expresses the relationship between the enzyme and the impurity, and can be used to calculate the subsequent purification procedure.

It is clear that in the case of a pure substance, graph 5 would be a straight line passing through the origin.

It is a pleasure to express our indebtedness to both Dr. G. S. Adair and Dr. D. W. G. Style for their invaluable advice on many points.

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Structure of the Photon

By analogy with the existence of both positive and negative electric charges, one may envisage the possibility of the existence of negative as well as positive mass. The non-appearance of such particles can be readily explained, but in at least one case the hypothesis leads to useful deductions.

Consider a particle of mass and charge both equal to those of the electron, but opposite in sign. In free space the behaviour of a doublet consisting of an electron and of this particle (termed provisionally the a-tron) shows considerable similarity to that of a photon.

When the electron and a-tron coincide, there is no resultant charge or mass; no external effects are observed and to all intents and purposes the doublet is non-existent. If the two particles are separated by a suitable amount of energy a force of attraction arises which accelerates the electron towards the a-tron, and the latter away from the electron (due to its negative mass). The doublet as a whole travels forward with as limiting velocity the velocity of light. The separation of the two particles determines the energy E of the doublet, but not its velocity.

The 'effective' mass M of the doublet in motion is determined by its energy E;

$$m = E/c^2 \qquad (1)$$

Its momentum p ($p = E/c$) can be lost in part by collision with matter (Compton effect), without changing the limiting velocity c.

In free space the doublet behaves as a unit; in the presence of a positive gravitational mass it is accelerated bodily towards the latter. It cannot be subdivided without losing its fundamental properties, and this property it shares with the photon.

To a stationary observer the emission of a doublet by a moving body results in a change in wavelength due to the 'carry-on' of the electron, which is emitted after the emission of the a-tron (Doppler effect).

On interaction with matter, the doublet may disappear as a unit; for example, the a-tron may be

neutralized by an electron, thereby freeing the electron constituent of the doublet, together with a corresponding amount of energy (photo-electric effect)

The electromagnetic wave properties of the photon are paralleled by those of the probability waves of the doublet. The close analogy between them is demonstrated, for example, by the similarity in the laws of interference of electronic probability waves and of electromagnetic waves (electron and X-ray diffraction).

A photon of energy E has a wave-length $\lambda_p = hc/E$. A doublet of this energy has a de Broglie probability wave-length $\lambda_b = h/mc = hc/E$ (from equation 1). Thus the de Broglie probability wave-length of the doublet equals the electromagnetic wave-length of the photon in free space. Similarly, the velocity of the de Broglie waves ($u = c^2/v = c$) equals that of light. In a medium of refractive index other than unity this conclusion requires modification.

In free space the doublet can thus be represented by a sinusoidal probability wave, of wave-length λ and travelling with velocity c The square of its amplitude at any point is proportional to the charge and mass at that point.

The electric and magnetic fields associated with the photon arise, not from this sinusoidal variation in electric charge, but from the magnetic moment due to electron (and a-tron) spin. At rest, the magnetic moments of electron and a-tron coincide and neutralize one another. In motion it is assumed that they are perpendicular to the direction of motion. At any point the sinusoidal variation in electric charge density gives rise to a corresponding variation of the magnetic moment (which is proportional to it), and hence to that of both magnetic and electric fields.

The direction of magnetic moment of the doublet may be indeterminate around the axis of propagation or it may be parallel to a given direction, etc. In the first case, the waves are unpolarized ; in the second they are linearly polarized. Corresponding to the laws relating to the polarization of light are those relating to the spin of the electron and a-tron.

Further consideration of a duality of positive and negative masses appears capable of furnishing information on the nature of the electric field.

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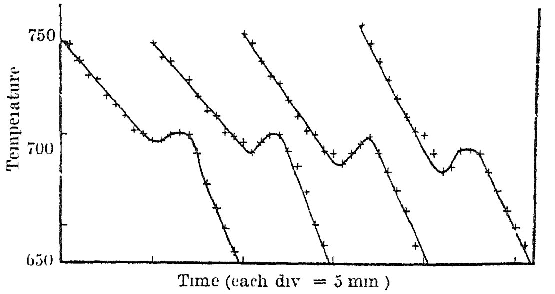
Dec. 23.

Polymorphy of Bismuth Trioxide

FROM thermal analyses, Guertler[1] concluded that bismuth trioxide, Bi_2O_3, existed in two forms, one stable above 704° C. and one stable below this temperature He was not able to prepare the high-temperature modification even by quenching.

From the smoke of burning bismuth, Sillén[2] prepared a second form of bismuth trioxide, which was proved by X-ray analysis to be different from the ordinary form. This new phase was called β Bi_2O_3 and the ordinary form α Bi_2O_3, and it was assumed that β Bi_2O_3 corresponded to Guertler's high-temperature form. Schumb and Rittner[3] have also prepared the β-form and shown that it is transformed to the α-form below 710°. However, they believe that the transitions $\alpha\ Bi_2O_3 \rightarrow \beta\ Bi_2O_3$ and $\beta\ Bi_2O_3 \rightarrow \alpha\ Bi_2O_3$ are rather slow reactions, and that the transition



COOLING CURVES FOR BISMUTH TRIOXIDE POWDER

point observed by Guertler was quite a different phenomenon, due to contamination of the molten oxide by the crucible employed.

Now if bismuth trioxide is heated to above 700° in a crucible of a resistant material and then allowed to cool, the mass is first seen to darken and then suddenly to glow, which strongly indicates the presence of a transition point. We have tried to investigate this transition under such conditions that contamination was practically excluded. A rather large quantity of pure bismuth trioxide was heated (in a platinum crucible) for about thirty minutes to below its melting point. The temperature was measured by means of a thermocouple inserted directly in the mass. The cooling curve very clearly shows a transition point at about 700° (see accompanying graph). Since the careful work of Schumb and Rittner has shown that the transition point of $\beta\ Bi_2O_3 \rightarrow \alpha\ Bi_2O_3$ is at about 710°, our experiments appear to indicate, in accordance with Guertler's, that the transition is more rapid than Schumb and Rittner have suggested.

When Guertler fused bismuth trioxide in a porcelain crucible, he obtained a new substance which he considered to be a third modification of the trioxide Sillén also prepared this substance and found that it was isomorphous with a synthetic compound with a body-centred cubic cell containing $Si_2Bi_{24}O_{40}$. The latter seems to be built up by spheres of composition $SiBi_{12}O_{20}$ with Si in the centre. Similar compounds were prepared from Bi_2O_3 and Al_2O_3 or Fe_2O_3. Their composition may be $Me_2^{3+}Bi_{24}O_{39}$

Schumb and Rittner have prepared a third form of bismuth trioxide called by them γ Bi_2O_3. Powder photographs and density measurements indicated a body-centred cubic cell containing $Bi_{26}O_{39}$. Though this cell is very similar to the body-centred cubic cell determined by Sillén, Schumb and Rittner do not consider the crystal structure to be the same. They hold that the differences in ionic radii between Bi^{3+} and the Me ions in $Si_2Bi_{24}O_{40}$ and similar compounds is too large to allow Bi^{3+} to be substituted for the Me ions.

We have prepared the γ Bi_2O_3, following the method of Schumb and Rittner. Their analyses did not entirely exclude the possibility that some of the bismuth is pentavalent, and the formula $Bi_{26}O_{40}$ did not seem improbable by analogy with $Si_2Bi_{24}O_{40}$. We therefore analysed for Bi^{5+}, but within the limits of error we found none. Consequently, the unit cell of γ Bi_2O_3 probably contains $Bi_{26}O_{39}$. Since the work of Sillén, Aurivillius has investigated a number of metal bismuth oxides seemingly isomorphous with $Si_2Bi_{24}O_{40}$. A summary is given below. Hitherto no mono- or divalent ions have been found to enter the central positions of Si^{4+}. The table shows that the lattice dimensions grow larger when the Si^{4+}

ions are replaced by larger cations and that even Ce^{4+} can be substituted for Si^{4+}. Unlike Schumb and Rittner, we therefore think that even Bi^{3+} can enter the central positions, though this will imply only fourfold co-ordination of oxygen ions around the central bismuth ions. As the unit cell of γ Bi_2O_3 contains 39 oxygen atoms, it is necessary to assume vacancies in the oxygen lattice.

Cube edges of various *Me*–Bi–O compounds of type $Si\,Bi_{4}O_{10}$.

Metal	*a* (A)	Ionic radius of metal (A)
Al^{3+}	10 14	0 53
Tl^{3+}	10 15	1 00
Fe^{3+}	10 16	0 67
Bi^{3+}	10 243	1 0
Si^{4+}	10 08	0 40
Ce^{4+}	10 20	1 02
Zr^{4+}	10 21	0 83
Pb^{4+}	10 23	0 84

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Bottom Deposits of the Red Sea

DURING the Egyptian Preliminary Expedition to the northern Red Sea in the R.R.S. *Mabahith* during 1934–35, which I accompanied, some sixty bottom-samples were collected, in particular from the three differently constituted areas, the Gulf of Suez, the Gulf of Aqaba and the Red Sea proper[1,2]. The mechanical composition and mineralogy of the bottom sediments were recently examined in the Department of Geology, Faculty of Science, Cairo.

The Red Sea is unique among the seas of the world in the fact that no permanent streams flow into it, and that only winds, mostly north-westerly, and occasional rain-torrents contribute material to its bottom. The sea is probably unique also for the very irregular bottom topography (excluding the Gulf of Suez); hence the nature and distribution of its bottom deposits are unmatched in other seas.

The sediments are coarser and better sorted, when they are secured from shallow or sloping bottoms (being finer in basins than on ridges and slopes) or from near land masses (including submarine ridges)[3]. The topography of the bottom seems to be the important factor in determining the physical constitution of the deposits. The irregular topography of the bottom gives rise to variety in the sediments. Contrasts appear between the deposits of the shallow and smooth Gulf of Suez, the deeper Gulf of Aqaba and the very irregular Red Sea proper. The Gulf of Suez, because of its flat bottom, has deposits with but little variation in their statistical data, in contradistinction with deposits on the very irregular bottom of the Red Sea, which have rapid changes in the corresponding statistical constants. The difference in environment is also shown by the fact that the sediments of the Gulf of Suez, though of shallow origin, are finer and less sorted than those of the Gulf of Aqaba or the Red Sea shallow environments. The peculiarity of the Gulf of Suez is also reflected in the mineralogy of its sediments, which are much richer in authigenic pyrites than either the Gulf of Aqaba or the Red Sea. The Gulf of Suez sediments are, in fact, comparable with normally sorted sediments from continental shelves; the Gulf of Suez is itself a shallow flat shelf filled with surface water of the Red Sea and descending at its mouth abruptly to a depth five times greater than its own. It is to be noted that the chemistry of the bottom deposits showed contrast in the three main regions investigated[4].

The mineralogy of the sediments is uniform over the different provinces and thus contrasts with that of the usual basins of deposition. Local variations are, however, caused by contamination from local source rocks or variation in the environmental conditions of deposition[5]. Such uniformity in the mineralogy of the Red Sea bottom sediments, which are mainly carried by wind, and the absence of sedimentary petrographic provinces, are the main characteristics of wind-borne detritals The conclusions of Sujkowski, who examined bottom deposits from the middle and south-eastern parts of the Sea, that the characteristic of the deposits, because of the absence of any chemical decomposition and lack of water transportation, is the presence of the easily weathered, coloured minerals and the common rock-forming minerals of crystalline rocks in abundance in a fresh state[6], are invalid as he overlooked the factor of provenance. The recent dunes of the great African Sahara, where conditions that favour mechanical disintegration rather than chemical decomposition of source rock prevail, but where sediments and not crystalline rocks dominate, contain a totally different assemblage (poor in the common rock-forming minerals: pyroxenes, amphiboles, micas and felspars) from that of the Red Sea[7]. On the other hand, the Nile sediments, which are water-borne, gave an assemblage of minerals with the same characteristics as those of the Red Sea bottom deposits[8]. Both formations, though of two different modes of origin, are remarkable examples of the richness of recent sediments (derived from crystalline rocks) in vulnerable minerals. The statement of White[9] that wind-borne sands contain less frequent heavy minerals than water-borne sands, and that the heavy minerals are less frequent in larger deserts than in smaller desert areas, is invalid as he did not take into account the factor of provenance in this case also.

The mineral assemblage of a sediment depends, in fact, on the following three main factors, which should be collectively taken into account when the nature of the assemblage is to be explained: (1) nature of distributive rocks; (2) type of weathering and mode of transportation; (3) post-depositional processes, leading to simplification of detrital grains[10].

The mineralogy of the clay fractions of the bottom deposits is, at present, under investigation.

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TIDES OF THE ATLANTIC OCEAN

PROF. J. PROUDMAN, professor of oceanography in the University of Liverpool, delivered the George Darwin Lecture at the Royal Astronomical Society on October 13, 1944, the subject of his lecture being "The Tides of the Atlantic Ocean" (*Mon. Not. Roy. Ast. Soc.*, 104, 5, 244, 1944).

Prof. Proudman gave a short history of the problem, starting with Whewell, who published the first co-tidal charts in 1833, which were based on reasoning of a largely non-dynamical character. Whewell's deductions that the tides of the Atlantic were generated in the Southern and Pacific Oceans, which Airy rejected and which Whewell himself had abandoned by 1848, continued, unfortunately, to be repeated for a long time in text-books. In 1874 Ferrel calculated, on dynamical principles, what the tides would be in canals along parallels of latitude stretching from one side of the Atlantic to the other. He thought that there might be an approach to conditions of resonance for a canal between Ireland and Newfoundland, and if a dyke extended from the Cape of Good Hope to the coast of South America, the tides in the North Atlantic would probably be very nearly the same as they actually are. In 1900 Harris took up Ferrel's work, and four years later constructed charts of co-tidal lines for all the oceans and seas; but as Proudman points out, his work involved a number of serious errors, among which may be noticed a mathematical mistake involving an error of three hours in the times of high water; the neglect of the resonance of transverse oscillations for the South Atlantic; lack of consideration of the effect of water in neighbouring regions; and failure to give adequate consideration to the dynamical effects of the earth's rotation.

In 1910 Poincaré discussed the energy implications of progressive waves, and in applying his principle regarding the influx of energy into any region and the forces which must balance it, he concluded that, in the arctic seas, the dissipation of energy by the friction of tidal currents on the sea bottom was always negligible; that the work done against the generating force was also negligible; and that the flow of energy out of the region was insignificant on account of the smallness of the Bering Strait. He therefore deduced that the arctic tides do not consist of a wave progressing from the Atlantic, but, as Taylor showed in 1918 and Jeffreys in 1923, friction is by no means negligible in shallow seas, and Poincaré's arguments could not be maintained.

A brief reference is made to Sterneck's co-tidal charts, which are not based on dynamical principles, but on observation; and then Defant's work is considered at length. Defant abandoned his work of 1924 in 1932 and confined his attention to the neighbourhood of the central line of the ocean and also to the part of the Atlantic south of Iceland. He started by assuming that the rotation of the earth does not affect the tidal conditions on the central line; that the transverse generating forces do not affect tidal conditions on the central line; and that there is no dissipation of energy to the south of Iceland. He considered two phases, differing by a quarter period, such that they agree with observations at the Azores and Tristan da Cunha, the node of one phase coinciding with the loop of the other, and his results show good agreement with the observations on these islands. Although Defant's assumptions cannot be regarded as anything more than rough approximations, conditions on the central line can be largely accounted for by means of longitudinal oscillations.

Prof. Proudman then turned to the results of his own researches, which are purely dynamical and are concerned with a study of a region of the Atlantic bounded by two parallels of latitude, those of 45° N and 35° S. He supposes that we are given either · (1) the general conditions to be satisfied along the coasts and the actual meridian-components of currents across the bounding parallels; or (2) the general conditions to be satisfied at the coasts and the actual tidal elevations on the bounding parallels; or (3) the general conditions to be satisfied at the coasts and the actual meridian-components of the currents on one bounding parallel and the actual elevations on the other bounding parallels. Then the tidal elevations and currents are mathematically determinate all over the region considered, including their values on the coasts. As we do not know the actual currents or the actual elevations or the bounding parallels, but we know the coastal elevations, the problem is considered the other way round. Given the general conditions along the coasts and the actual values of coastal elevations, the tides are mathematically determinate over the whole region considered, and Prof. Proudman solves the problem by considering a number of subsidiary problems of a different type, but limits of space prevent a detailed account of these, and a short summary of his work must suffice.

Selecting the parallel of 35° S. as the one along which certain conditions are prescribed, and taking the elevations and meridian components of current to be zero along this parallel, but allowing for all the generating forces, one particular solution is obtained. While the resulting oscillation is small in the South Atlantic, there are larger amplitudes in the North Atlantic, and a large co-tidal area exists here. A second particular solution is an oscillation which Prof. Proudman calls a north-going Kelvin-wave, and corresponds to currents along the meridians and to elevations, both of which increase exponentially towards the west. Considerable complications are produced by the curvature of the earth along the meridians, by variations in the width of the oceans and by variations in depth. A third solution gives a south-going Kelvin-wave, and again the currents in latitude 35° S. are along the meridian, but in this case both the elevations and currents increase exponentially towards the east. By assuming that the transverse currents follow a sine-distribution from coast to coast, two other solutions, called the north-going and the south-going Poincaré-wave, are obtained, and in these cases the amplitudes are small in the centre of the ocean.

The problem is to assign an amplitude and a time-origin to each Kelvin- and Poincaré-wave, so that when the four are added to the forced oscillation, the coastal elevations in the synthesis will agree with observations so far as possible. Prof. Proudman has made the sum of all the waves agree with observation at four points on the coasts, and he has chosen two of these points in latitude 32·5° S. and the other two in latitude 7·5° S., that is, south of the Gulf of Guinea and Cape San Roque, where the major irregularities of the basin begin. The north-going Kelvin-wave is the most important with an amplitude of 52 cm. and a high-water time of 1·8 hr. at the south-west corner of the region considered. The south-going Poincaré-wave is the next most important; it has an amplitude of 35 cm. and a high-water

time of 9·1 hr. at the south-west corner. The other two free waves have each an amplitude of 22 cm. at the south-east corner, and the high-water time of the south-going Kelvin-wave at this point is 10·8 hr, and that of the north-going Poincaré-wave 0 5 hr The agreement with observation is good as far as 5° S. latitude, but considerable divergences set in afterwards. Part of this divergence may be due to not including a sufficient number of Poincaré-waves, and Prof. Proudman hopes to obtain better results by including more of these waves than he has done in the present investigations.

PLANT DISEASE AND THE WEATHER

CLIMATE exerts an important influence on the spread and severity of plant disease—an influence long recognized, though not yet fully investigated. Some recent progress in this field was discussed in a symposium arranged by the Department of Plant Pathology of the West of Scotland Agricultural College at Auchincruive on November 8. The meeting was attended by the advisory pathologists for Scotland, the staff of the Plant Pathology Service of the Department of Agriculture for Scotland, members of the College staff, of the University of Glasgow and the Hannah Dairy Research Institute.

Dr. C. E. Foister, head of the Plant Pathology Service of the Department of Agriculture for Scotland, opened by a short review of progress since the Conference of Empire Meteorologists in London in 1929. It becomes increasingly clear that records taken with ordinary meteorological exposure do not provide the pathologist with all the data he requires. It is necessary to study weather within the crop, and to follow up such information by investigations with artificially controlled conditions. Physiological races of fungi, moreover, may react differently to weather conditions. The distribution and occurrence of yellow rust of wheat in Scotland, for example, suggests the existence of different races varying in their reaction to environmental factors. Several parasitic fungi, common in England and Wales, are rare or unknown in Scotland, or confined to certain areas there. They include *Puccinia triticina*, *Septoria tritici*, *Rhyncosporium secalis*, *Phytophthora cactorum*, *Diaporthe umbrina*, *Heteropatella antirrhini* and the Dutch elm disease.

The rhododendron bug has twice invaded Scotland, but has failed to establish itself. How far are these apparent absences due to weather ?

Dr. John Grainger, head of the Plant Pathology Department at Auchincruive, considered the aerial climate, the soil climate and the major effects of weather, with special reference to work carried out at Auchincruive in 1944. He showed how daily averages of aerial temperature and humidity inspired further work; but only continuous records within the crop revealed true phenological relationships. Chocolate spot of the field bean, bean leaf spot (*Ascochyta fabæ*), and *Erysiphe graminis* on oats, all showed some increase of attack with rising relative humidity; but the real correlation was between disease intensity and the number of hours per day with complete saturation. Drain-gauge studies at Auchincruive have shown the large amount of rainfall evaporated from the soil. One aspect of aerial climate often neglected is that of conditions of storage for seed; it might be possible to provide conditions under which the parasites lose their viability before the seed. The major effects of weather are mainly important in so far as they transport fungal spores from one area to another. It has been found, however, that large teleutospores of some rust fungi are not carried more than a few yards by wind Climate cannot, of course, be controlled, but the practical value of weather studies lies in the following points: (1) its value in life-history and mycological studies; (2) its help in raising immune or resistant crop varieties; (3) virus-infected crops should be rogued within such temperature limits as the symptoms are not masked, (4) the time of farming operations can be adjusted to avoid some infections, (5) excessive atmospheric humidity may possibly be controlled in some parts of Scotland by adequate drainage; (6) conditions of seed storage may be devised to minimize seed-borne disease; (7) growers may be advised when to spray in order to eliminate disease epidemics.

The role of weather as direct pathogen in causing frost damage to fruit blossom was discussed by Dr. C. E. Cornford, of the Midland Agricultural College. Field experiments with orchard heaters were described which showed that the hot air they supplied was chilled or warmed by several other agents. These included katabatic winds, altitude, the amount of cloud, the presence or absence of large dense grass exposed to the sky, the humidity of the air and the dryness of the trees and soil.

Dr. B. T. Cromwell (Auchincruive) presided over the discussion which followed. Mr. A. Heddle (Edinburgh) contrasted the epidemic of yellow rust in 1943 with its scarcity in 1944. The problem is complicated by the long growing-period of winter wheat. Dr. Mary Noble (Edinburgh) and Dr. Elizabeth Gray (Aberdeen) then contributed, and it appeared that winter wheat was generally much more susceptible than spring wheat in Scotland, and the severity of epidemics when they did occur was such that further detailed experiment was advisable. Dr. Grainger answered questions on frost damage in Dr. Cornford's absence. His own experience showed that oil heaters only raised the temperature of the air in their immediate neighbourhood by about 4° F. Evaporation from the buds lowered their internal temperature by 2° F., giving a net internal rise of about 2° F. Trials with humidified heating raised the air temperature near the source by 2° F., without internal cooling, thus resulting in a very considerable saving of fuel. Mr. Dovaston (Auchincruive) raised the question of avoiding grass cover in orchards subject to frost damage, but Dr. Cromwell and Mr. R. D. Reid (Auchincruive) held that grassing down was a very practical method of maintaining nutritional balance of the trees, particularly with regard to nitrogen.

Dr. Foister, Dr. Cromwell and Mr. Reid considered the occurrence of *Cladosporium* mould in tomato glass-houses. The disease was often more severe in low-lying houses on sandy soil than in higher situations on heavy soil; the factor of humidity did not seem to be the only one, and the admission of ultra-violet rays through 'Vita' glass did not eliminate the fungus. This discussion again pointed to the need for more detailed work. Dr. R. Laird (Ayrshire) mentioned that *Ascochyta fabæ* and chocolate spot were more severe in low-lying, sheltered fields, but remembered that certain periods when these diseases were spreading were characterized by hot, dry days. Dr. Grainger explained, however, that long periods of complete

saturation occurred during the nights at that time—a fact which again stressed the value of continuous records within the crop. Dr. C. L. Whittles (Auchincruive) urged the necessity for continuous records of such soil factors as pH, water content, conductivity and oxidation-reduction potential

INDUSTRIAL DEVELOPMENT IN AUSTRALIA

THE paper "Scientific Aspects of Australia's Industrial Development", which Mr. G. B. Gresford read before the Royal Society of Arts on January 16, naturally covers a good deal of ground in common with the annual reports of the Commonwealth's Council for Scientific and Industrial Research, though the account is rather more up to date and in a larger setting. Mr. Gresford referred particularly to the recent plans of the Australian wool industry, stimulated no doubt by competition from artificial fibres, for a large expansion of scientific research Part of the large sum which the Australian Wool Board proposes to raise by increasing the levy on growers of wool would be spent by the Council for Scientific and Industrial Research on biological and textile research, and part would go towards economic research and publicity. Whether or not the opinion is justified that fundamental research will lead to the improvement of wool yield and quality, the cheapening of processing and the development of new and novel fabrics so that wool can more than hold its own, the link between science and the wool industry will become closer.

After a reference to research in connexion with grain crops such as wheat, and the significance of the results in the field of nutrition and developments in the manufacture of fertilizers and sulphuric acid, Mr. Gresford mentioned particularly the part science has played in the development of the mining and metal industries. Investigations on flotation, and particularly the discovery of the collecting properties of potassium ethyl xanthate for the sulphide minerals, have led to the present high recoveries of lead and silver in the flotation sections of the mines. The work at the University of Melbourne on fundamental physical chemistry of the flotation process, which for ten years before the War was financed by a group of Australian mining companies, is now partly carried on by the Council for Scientific and Industrial Research. Work in new fields has suggested possible extensions of the flotation process to the concentration of new minerals. Mr. Gresford also referred to the continuous lead refining process for dressed smelter bullion evolved by the staff of the Broken Hill Associated Smelters as a striking example of the application of physical chemistry to an industrial process.

The paper industry, and particularly the development of processes for a wide range of papers from eucalyptus woods by a chemical or mechanical method, provides a further example of the solution by scientific research of a problem deemed intractable, and which has now made the Australian industry almost entirely independent of imported materials. Referring to the universities as sources of supply of scientific personnel for industry, Mr. Gresford said that the demand at present greatly exceeds the supply, and if maintained it will involve a corresponding expansion of the universities. Plans have been made for a considerable expansion of Government research activities, but further expansion of research in industry is desirable So far, scientific exploration has not revealed any sources of flow oil in Australia; attention has not been given to the synthetic production of liquid fuels from coal, although the brown coal deposits of Victoria are very similar to those used in Germany for this purpose. Organic chemical industry on a large scale has scarcely been started and the development of the chemurgic industries, utilization of agricultural wastes, alkaloids and essential oils are other fields awaiting the application of scientific methods in Australia.

SYNTHESIS OF BIOTIN

A SYNTHESIS of biotin by S. A. Harris, D. E Wolf, R Mozingo, R. C. Anderson, G. E. Arth, N R Easton, D. Heyl, A. N. Wilson and K Folkers, of the Research Laboratory of Merck and Co, Inc., has recently been described (*J. Amer. Chem Soc.*, **66**, 1756, 1944)

The process involves several steps: *l*-cystine is reduced in liquid ammonia with sodium and coupled with chloroacetic acid to give β-(carboxymethylmercapto)-alanine, subsequent benzoylation and esterification of which yielded the dimethyl ester of N-benzoyl-β-(carboxymethylmercapto)-alanine. The diethyl ester was obtained by condensing thioglycolic ester with the ethyl ester of N-benzoyl-β-chloroalanine, derived from N-benzoylserine by esterification and chlorination with thionyl chloride. The dimethyl ester was treated with sodium methoxide in methanol to give the radium salt of 4-benzamido-3-ketotetrahydro-2-thiophenecarboxylic acid methyl ester, racemization occurring during the reaction. The sodium salt was hydrolysed and decarboxylated in an aqueous acetic acid – hydrochloric acid solution to give 4-benzamido-3-ketotetrahydrothiophene. The valeric acid side-chain was introduced by means of an aldehyde prepared from glutaric acid. The acid was converted in turn to glutaric anhydride, glutaric acid monomethyl ester, γ-carboxymethoxybutyryl chloride, and finally to methyl γ-formylbutyrate by a Rosenmund reduction.

The aldehyde ester, condensed with the ketone, 4-benzamido-3-ketotetrahydrothiophene, with piperidine acetate as catalyst, yielded the methyl ester of 4-benzamido-3-keto-$\Delta^{2,\delta}$-tetrahydro-2-thiophenevaleric acid, which reacted with hydroxylamine hydrochloride in pyridine to yield the methyl ester of 4-benzamido-3-oximino-$\Delta^{2,\delta}$-tetrahydro-2-thiophenevaleric acid, reduction of which by zinc dust in an acetic acid – acetic anhydride mixture gave two compounds, one the methyl ester of 3-acetamido-4-benzamido-4,5-dihydro-2-thiophenevaleric acid. Hydrogenation of this over a palladium catalyst and fractional crystallization of the products gave two racemates of the methyl ester of 3-acetamido-4-benzamidotetrahydro-2-thiophenevaleric acid. Each of these was hydrolysed with barium hydroxide, and subsequent treatment of the products with sulphuric acid gave the corresponding sulphates of the 3,4-diaminotetrahydro-2-thiophenevaleric acids.

The acids, when treated with phosgene, yielded two racemates of hexahydro-2-oxo-1-thieno[3,4] imidazole-4-valeric acid, which will be called *dl*-biotin, and *dl*-allobiotin. The *dl*-biotin was resolved through its esters with *l*-mandelic acid to give biotin.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, March 10

Institute of Physics (South Wales Branch) (in the Physics Department, University College, Swansea), at 2.30 p m —Inaugural Meeting Dr. C. Sykes "Physics in Metallurgy".*

Monday, March 12

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, London, W C.2), at 2 30 p m.—Mr. Geoffrey Crowther: "An Economist Looks at British Agriculture".

Royal Institute of Chemistry (in the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 4 p.m.—Annual General Meeting

Society of Chemical Industry (Yorkshire Branch) (in the Metropole Hotel, King Street, Leeds), at 6.15 p.m —Mr. S W. Butterworth · "Flour"; Mr. E. F. Eaton · "Colours in Foods".

Royal Institute of Chemistry (joint meeting with the Institution of Rubber Industry) (in the James Watt Institute, Birmingham), at 7 p.m.—Dr. W. J. S. Naunton "Rubber Chemicals—Past and Present Influence on Synthetic Rubber".

Royal Geographical Society (at Kensington Gore, South Kensington, London, S W.7), at 8 p.m —Mr. Christopher Sandeman: "Northern Highway of Peru".

Tuesday, March 13

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres.R.S: "Nerve Endings and Chemical Transmitters", (2) "Adrenaline and Acetylcholine, Adrenergic and Cholinergic Nerves".

Institution of Electrical Engineers (Radio Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m —Discussion on "Colour Television" (to be opened by Mr. L. C. Jesty).

Royal Photographic Society (Scientific and Technical Group) (at 16 Prince's Gate, South Kensington, London, S W.7).—Dr. H. Baines: Presidential Address.

Wednesday, March 14

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr J. H. O. Bunge "The Thames Barrage and its Importance in the London Reconstruction Plans".

Society of Chemical Industry (Food Group, Microbiological Panel) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Miss E. M. L. Elliot · "Bacteriological Aspects of the Laboratory Examination of Meat", Mr. L. B A. Grace: "Aspects of Practical Meat Inspection".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Anniversary Meeting.

Royal Meteorological Society (in the small Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 4.30 p.m.—Major H. C. Gunton "Report on the Phenological Observations in the British Isles from December 1943 to November 1944".

Institute of Petroleum (in the Lecture Theatre of the Royal Society of Tropical Medicine, 26 Portland Place, London, W.1), at 4.30 p.m.—Thirty-second Annual General Meeting.

Institution of Electrical Engineers (Transmission Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p m. —Mr. W. Kidd and Mr. E. M. S. McWhirter: "Operational Control of Electricity Supply Systems".

Society of Chemical Industry (South Wales Section) (joint meeting with the Royal Institute of Chemistry) (at the Technical College, Newport, Mon.), at 6.45 p m.—Dr. H. E. Crossley "The Nature and Significance of the Inorganic Substances in Coal"

Thursday, March 15

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. E K. Rideal, F.R.S. · "Reactions in Monolayers" (Liversidge Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg F.R.S.: "Some Physical Problems of the Solid State".

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Mr. L Dudley: "The Development of Stereoscopic Photography and Radiography".

Friday, March 16

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m —Mr. J. Z. Young 'The Structure, Degeneration and Repair of Nerve Fibres".

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 5 p.m.—Special General Meeting.

Institution of Electrical Engineers (Measurements Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Dr. G. F. Tagg. "The Temperature Compensation of Indicating and Recording Instruments".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5 30 p m —"Invention after the War" (to be introduced by Mr. Harold Sinclair, Mr. E. W. Moss and Mr. H. W. Cadman).

Saturday, March 17

Biochemical Society (at the Middlesex Hospital Medical School, London, W.1), at 2 p.m.—Annual General Meeting.

Institution of Mechanical Engineers (Graduates' Section) (at Storey's Gate, St. James's Park, London, S.W 1), at 3 30 p m — Mr. A. H Lloyd "British Machine Tools during the War" (Annual Lecture).

Royal Photographic Society (Scientific and Technical Group) (at 16 Prince's Gate, South Kensington, London, S W.7) —Mr. L V Chilton. First Renwick Memorial Lecture.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in Electrical Engineering for National Diploma and Higher National Certificate Courses in the Crumlin Mining and Technical College—The Director of Education, County Hall, Newport, Mon. (March 16)

Lecturer (full-time) in Engineering Subjects—The Acting Principal, Technical Institute, Clowne, Chesterfield (March 17).

Assistant Biochemist—The House Governor, General Hospital, Birmingham, 4 (March 17)

Assistant Civil Engineer (permanent) by West Ham County Borough to take charge of the Civil Engineering Section of the Borough Engineers Department—The Ministry of Labour and National Service, Appointments Department, Central (T. and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1426.XA) (March 20).

Metallurgist of Degree standard by large Engineering concern in S E. England—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London W.C.2 (quoting Reference No. F 3537 XA) (March 21)

Lecturer (non-resident) in Geography, with some Mathematics —The Principal, Diocesan Training College, Salisbury (March 24).

Lecturer (full-time) in the Department of Electrical Engineering, and a Science Lecturer (full-time) in the Department of Building, of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool, 1 (March 24).

Technical Inspector and Grader in the Milk Product Division of the Ministry of Food at Colwyn Bay—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3397 A) (March 26).

Lecturer in Spinning—The Registrar, College of Technology, Manchester, 1 (March 28).

Assistant Bacteriologist (temporary), and Laboratory Assistant in Bacteriological Section of Laboratories (temporary)—The Clerk to the Board, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (endorsed "Assistant Bacteriologist" or "Laboratory Assistant" as the case may be) (March 31).

Principal of the County Mining and Technical School, Nuneaton—The Organizer of Further Education, Council House, Nuneaton (March 31).

Principal of the Leigh Municipal College—The Secretary of the Local Higher Education Committee, Education Department, Town Hall, Leigh, Lancs. (March 31).

Senior Assistant in the College Library—The Registrar, King's College, Newcastle-upon-Tyne (March 31)

Lecturer in Genetics—The Secretary of University Court, The University, Glasgow (April 7).

Reader in Botany and Head of the Botany Department, tenable in the Durham Division of the University—The Registrar, The University, 46 North Bailey, Durham (April 14)

Professor of Economics—The Registrar, University College, Singleton Park, Swansea (April 21).

Registrar—The Bursar (acting Registrar), The University, Leeds, 2 (April 30).

Sedleian Professorship of Natural Philosophy—The Registrar, The University, Oxford (June 2).

Assistant in the Department of Agricultural Economics under the Ministry of Agriculture Advisory Scheme—The Secretary and Bursar, Seale Hayne Agricultural College, Newton Abbot, Devon.

Metallurgists (2) to undertake research in the welding of light alloys—The Secretary, British Welding Research Association, 2 Buckingham Palace Gardens, London, S.W.1.

Lecturer in Science (mainly Biology)—The Principal, Training College, Hereford.

Lecturer (woman) to develop courses in Gardening and Rural Science, and a Lecturer (part-time) with suitable qualifications and experience to undertake with the students Voice Production, Speech Training and Speech Therapy—The Principal, St. Mary's College, Cheltenham.

Teacher (full-time) of Mathematics—The Principal, Enfield Technical College, Queensway, Enfield, Middx.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Report on the Work of the School for the Year 1943–44. Pp. 44. (London: London School of Hygiene and Tropical Medicine, 1945.) [92

Co-operative Electrical Research. Pp. 62. (London. British Electrical and Allied Industries Research Association, 1944.) [92

Tory Reform Committee. Bulletin No. 9: Approved Societies. Pp. 4. (London: Tory Reform Committee, 1945.) [92

Catalogues

Technical and Scientific Books. Pp 32. (Brooklyn, N.Y.: Chemical Publishing Co., Inc, 1945.)

Recent Purchases of Rare Books. (Catalogue No. 70.) Pp. 28. (Caerleon: Ifan Kyrle Fletcher, 1945.)

NATURE

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FORESTRY AND AGRICULTURE

IN previous issues of *Nature* (Sept. 25, 1943, p. 337, and Dec. 2, 1944, p. 693), we have reviewed the proposals made by H.M. Forestry Commissioners and the Royal Forestry Societies of Scotland and England for the future administration and control of forestry in Great Britain. Matters were taken an important stage further on February 15, when Sir John Anderson made a statement in the House of Commons that for "securing more complete and more direct Ministerial and Parliamentary control, the better co-ordination of the development of agriculture and forestry, and the most efficient use of the woodlands which survive the War, and of further land available for afforestation", it was best to "enlarge the sphere of the Ministry of Agriculture and Fisheries and the Secretary of State for Scotland, so that these Ministers may become jointly responsible for forestry policy and for supervising the measures for its execution". This decision—reached, it is reported, after prolonged consideration of various possible alternatives—should occasion no great surprise, and should be admitted to come as near as it is possible to come to reconciling the divergent views expressed on the subject. Details are not yet available, but it was definitely stated that under this arrangement, "the Forestry Commission will be retained as a single continuing expert body responsible directly to Ministers for advice on forest policy and for carrying out operations including training, research and forest holding".

There has been general agreement among those interested that the existing position was no longer satisfactory, however well it may have been suited to the conditions prevailing when the Commission was set up in 1919. Critics have reiterated their view that there should be direct Ministerial and Parliamentary control in place of the peculiar position, only paralleled to some extent by such bodies as the Ecclesiastical Commission, of being included in no department of Government and controlled only in financial matters by the Treasury. They have also expressed dissatisfaction with the composition of the Commission and the method of appointment to it. It is always easier to point out what is believed to be wrong with an organization than to provide a certain remedy, and though the various proposals run on fairly similar lines, it cannot be said that there is unanimity as to what would at this stage constitute the best composition of a revised Forestry Commission and how appointments should be made to it. It will be noted that there is fairly general agreement, however, that in one form or another, a commission does provide the best machinery for carrying out the forestry work required to be done in Great Britain during the post-war period.

Taking first this question of Ministerial control, it will be remembered that the Commission's own proposal (Cmd. 6447, par. 55) was that if, despite its recommendations, Parliament should wish it to be placed under the control of a Minister, that Minister should be the Lord President of the Council, perhaps

working through a committee for forestry including the Secretary of State for Scotland, the Minister of Agriculture and the chairman of the Commission. The Royal Scottish and Royal English Forestry Societies made the same recommendation, but they set out their reasons at some length (Report on Post-war Forestry, 1944, p. 23). To the layman, it would seem obvious that if it is advisable to include forestry in an existing Ministry, it should go with the closely related field of agriculture, and he would probably find it difficult to imagine why both the Commission and its critics should wish forestry to be included among the bodies under the control of the Lord President, which include the three important research bodies, the Medical Research Council, Agricultural Research Council and Department of Scientific and Industrial Research. What is it, then, that prompts the forester to look for some alternative to such linkage at the Ministerial level with agriculture? The answer lies primarily in his belief that there is a real risk that a Ministry of Agriculture might not accord to forestry that share of interest, staff and total available resources to which forestry considers itself entitled; that, in the terms of a much repeated quotation, agriculture might in fact treat forestry as its handmaid, taking moreover an out-of-date view of the proper relations between mistress and handmaid. If then the further question is put—What grounds has the forester for this mistrust?—reference might be made to the history of the relationship between the two forms of land use in certain parts of the British Empire, where forestry, when it was in competition with agriculture, appears to have had a difficult struggle to obtain a full hearing of its case and adequate recognition. Some of these points do indeed appear to support the argument; but clearly much depends on the setting, and it is easy—again ignoring the setting—to find illustrations working in the opposite sense; for example, the ultimately successful demand of the United States Forest Service early in its history to be included in the Department of Agriculture, and the strong opposition more recently to any proposal to break up this administrative arrangement. The situation seems to call for careful consideration and, if necessary, the provision of some such safeguard as expressly earmarking funds for forestry. In view of the known interest in forestry of the Ministers who are at present responsible for agriculture in Britain, foresters need have few fears; but both appointments are political and the incumbents subject to change.

There was, moreover, thought to be a constitutional consequence of placing forestry in the same hands as agriculture, which British foresters generally deemed highly undesirable, namely, a splitting up of the existing single organization for Great Britain as a whole into two parts, one for Scotland under the Secretary of State for Scotland, and the other for England and Wales under the Minister of Agriculture and Fisheries. H.M. Commissioners are emphatic on the point (Cmd. 6447, par. 533), and so are the two Forestry Societies, though they consider the difficulty could be got over (cf. their Report, p. 23). Unity is considered necessary to "ensure the high standard and *esprit de corps* expected of the Forest Service, adequate services for research, education and information, and a strong front to carry out an agreed national policy". It will be noted that this need arises from the fact that in Britain, even after the considerable expansion contemplated, forestry will still remain as a relatively small item on the national programme. Subdivision would mean further loss of strength, and the two services would each, in several aspects of their work, be too small for efficiency with economy. Obviously there must be a large measure of decentralization, permitting matters which are of purely Scottish concern being dealt with in Scotland, but no significant change from the present position will be required to ensure this. There will be dissatisfaction in Wales if special provision is not included to ensure the fullest consideration of Welsh interests, particularly as Wales will certainly be called on to provide a large proportion of the land required for afforestation. The existing consultative committees have been found to be too exclusively consultative, too lacking in power to press their views, to be acceptable.

It will be noted with approval that the Government has taken into account the need of the better co-ordination of agriculture and forestry. This is in keeping with the times, for this need is becoming more and more apparent to thinking men in both professions, as well as to those responsible for general administration. The Forestry Commission has often been charged with disregarding it when acquiring land for State afforestation. It is of even greater importance in the case of privately owned woodlands, which must almost always be handled as an integral part of a mixed estate—woodland, arable and pasture, all having their appropriate balanced parts to play in the general rural economy.

The statement made in the House of Commons also indicates that although we shall continue to have a Forestry Commission appointed by the Crown, its composition will be fundamentally altered by dropping the practice which has grown up of appointing representatives of each of the three chief political parties—one of the Commissioners had to be a member of the House of Commons to act as spokesman.

Men of science will note the specific mention of research as remaining under the control of the Forestry Commission, and perhaps wonder why it is not proposed to bring it under the Agricultural Research Council, as this would seem to be a logical step if the Ministry of Agriculture is to become responsible for forestry. A further announcement will be looked for with interest, as there have been numerous charges of inadequate attention to research in the past; but it may be noted that it would be quite possible for the necessary work to be shared between the Agricultural Research Council and the Ministry. The Ministry of Agriculture already has its own research stations for special problems, particularly those of a highly technological nature, and there are strong reasons why the Forestry Commission should in any event continue research of this type on

a wider scale than hitherto. Research of a more fundamental nature, which it has been the practice to 'farm out' to universities and other institutions wherever the best facilities were considered to exist for handling the individual problems, could perhaps more appropriately be taken over by the Agricultural Research Council, suitably enlarged by inclusion of persons with expert knowledge of the scientific aspects of forestry. There is a vast field for research into primary forest soils, tree physiology, and forest ecology in the widest sense, that has hitherto been much neglected. A variety of reasons for this neglect has been adduced, including experimental difficulties, lack of realization of the need for research, and lack of appreciation of the practical importance of the work. The essential requirement now is to remedy this, whatever is decided to be the best administrative arrangement to that end.

The accomplishments of the Forestry Commission during the first twenty-five years of its existence are reviewed in an article by Prof. E. P. Stebbing appearing in this issue (p. 317). If not a few matters are found for criticism, the reasons are often to be traced to the conditions under which the work has had to be done. It is indisputable that a great deal of valuable work has been accomplished during this quarter of a century, the completion of which would in any event have been a very appropriate time to take stock of the position reached. The initial difficulties involved in launching forestry as a new State activity have been successfully met. The nation's requirements can now be re-assessed and plans laid for a further period on the long-term views essential to sound forestry. In particular, we should now leave behind us the over-emphasis that has been laid on the afforestation aspects, give more attention to tending and management, and to preparing for the utilization problems that will shortly be upon us as the large acreages of plantation come into production. But the most significant feature of development to be anticipated in the draft legislation we are promised shortly is the proposed extension of the State's direct interest in some two million acres of privately owned forest. The Commissioners will need much imagination, tact and skill if at the end of the second twenty-five years they are to record as much progress in this field as they can record for their afforestation work since 1919. We believe this to be possible, and we certainly wish them every success in their task.

THE ROYAL SOCIETY, 1660–1940

The Royal Society, 1660–1940

A History of its Administration under its Charters. By Sir Henry Lyons. Pp. x+354. (Cambridge: At the University Press, 1944.) 25*s*. net.

AFTER Sir Henry Lyons had finished his work on the fourth edition of the "Record of the Royal Society", he wrote in June 1940 to the present reviewer: "I have learned that what is badly needed is a new 'History', for, as you know, Weld's ends at 1830. . . . Greatly daring I started on this about 2½ years ago and have got my first *rough draft* of half of it in shape already. Now that I have got most of my facts collected and checked I see my way more clearly . . ."; and again, in November 1941, "The further I get with it the less satisfied I feel. . . . The subject tempts one to fling a wide net, but I have tried to keep to the story of how the Councils and the Fellows carried out their trust as laid down in the Charters, and with what degree of success. . . .". Notwithstanding the dislocations and discomforts of war-time aggravated by growing illness, he steadfastly completed that task, and lived to see his text in print but not to see it published. In the book, he says that he regards it as the introduction to a second volume which must be left for another hand to write a century or two hence: a remark which well illustrates the sense of continuity that permeates his work; and indeed, every fellow of the Royal Society should, with like diffidence, be a 'student of perpetuity'.

After a note by Sir Henry Dale, president of the Royal Society, and the author's introduction, the seven chapters of the book flow in chronological order from the sixteen-forties to 1940 (with repetitions wherever the author has not let system stand in the way of narrative needs), so as to bring out well-marked successive changes in the Society's life. Appendixes give a full translation of the second Charter (1663) into English, and statistical data; and there is a full index of names and subjects.

Throughout the book the author repeatedly insists —and produces evidence for it—that a scientific society can be run only by scientific men. The Charter of 1663 had expressed the lofty vision and purpose of the scientific founders and their wise lay supporters; but their momentum waned with the century; and during the seventeen-hundreds and later, the growing proportion of non-scientific fellows exercised, as the author shows, "a restraining influence on the Society's activity and hindered its steady growth as a scientific institution; after 1820 the control of the Society passed into the hands of men of science with the result that it quickly became what its founders had originally intended it to be, an institution devoted wholly to the advancement of scientific knowledge".

As would be expected from Sir Henry Lyons—a fellow of the Society for thirty-eight years and its treasurer for ten—the evidence which he presents is never guesswork; he always goes to original sources; much is from documents not hitherto used for publication; and, wherever he can, he adds quantitative data. Thus, not only is the book full of interesting facts about persons, but also it discusses such matters as lengths of tenure of office, the number of meetings of Council held in different years, the attendances at them, the representation on them of different occupations, scientific and other, their administrative and legislative acts and controversies, and the finances of the Society as far back as records go.

The graph on p. 344 plots the number of fellows for each quinquennium from 1663 until 1940, and is interesting. A few years after the foundation there were some 215 fellows, about a quarter of them scientific; but by the sixteen-nineties there were only 115, the nadir in numbers. The ensuing rise went on for a hundred and fifty years, and in the early eighteen-forties the fellowship touched its numerical peak, 766. But now began to be felt the reformation of control and administration which the author calls "The Scientific Revolt, 1820–1860"; and, new elections of laymen having ceased, the total

number thenceforth fell, and so steadied down to about four hundred and sixty fellows and about forty foreign members, near which it has stayed for the past half-century.

Any serious work of history which scrupulously sets forth the evidence for its own inferences is, to some types of reader, dull. These types will be little attracted by this book; but it is not for them that Lyons wrote it. A scientific man and a careful historian, he wrote for his fellows; and perhaps above all for those who have or might have some part in the conduct of the Royal Society. There is none of such persons who should leave this work unread; it will teach them much of practical value. One of the many lessons implicit in it is that lively administration is essential to the furtherance of science but yet must be kept subservient to it. The Society has long learnt this; but it is sometimes forgotten by other planners, in their enthusiasm for logic and systems, that the best men of science are each *sui generis*, not units for regimentation, but beings for whose individual activities *qua* scientists the organization of society must elastically provide.

There is also another kind of reader who would well profit from some study of this book: namely, the general historian. For in the long run of history, thought proves more potent than engines; and the phases of the Royal Society in the past three centuries have partly reflected, but partly originated, deep changes of general thought in the nation at large, and beyond; and, without doubt, the recognition and tracing of these correlations enlightens real history. J. I. O. MASSON.

THREE MEN OF SCIENCE

Famous American Men of Science

By J. G. Crowther. Vol. 2: Thomas Alva Edison; Josiah Willard Gibbs. (Pelican Books, A.105.) Pp. 160. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 9*d*.

S. Z. Ferranti

(Science in Britain Series: Published for the British Council.) By L. Randell. Pp. vi+30+4 plates. (London: Longmans, Green and Co., Ltd., 1943.) 1*s*. net.

IT would be difficult to select two men of science who by ancestry, upbringing, development and achievement differed more widely than Thomas Alva Edison (1847–1931) and Josiah Willard Gibbs (1839–1903), whose careers are described in Mr. J. G. Crowther's book. Of Dutch descent, Edison's forbears were physically strong, long-lived and commercial, while Gibbs came of British stock, less robust and devoted to academical studies. Of intensely practical habit of mind, Edison was given to inventing as much as Gibbs was to abstract reasoning. When during the Civil War of 1861–65 Gibbs was studying and lecturing in the seclusion of Yale, Edison, a mere boy, was selling and publishing the first newspaper printed on a train and beginning his career in telegraphy. Gibbs inherited ample means for his needs; Edison had to make his own fortune. Edison owed nothing to teachers, Gibbs everything, and from the age of twenty-six to twenty-nine was able to study under famous physicists in Europe; but both made notable contributions to scientific and industrial progress.

To understand Gibbs's work, however, a thorough grounding in scientific principles is necessary, but everyone can appreciate Edison's hundreds of inventions, his lamps, dynamos, phonographs, etc. It is impossible to compare the two men; they were as different in temperament, character and mode of living as Cavendish and Trevithick. Mr. Crowther rates Edison as "the greatest inventor recorded in history"; but that and other statements only provoke one to thought, just like the story of the members of a British scientific society who, balloting for the greatest twenty scientific men since the Renaissance, chose in order, Newton, Darwin, Faraday, Einstein and Gibbs. One of Gibbs's contemporaries who worked at thermodynamics was John Macfarlane Gray (1832–1908); but Gray was not, as Mr. Crowther says, "chief engineer of the British Royal Navy", his official position was examiner of engineers for the Board of Trade.

In the same category of men of genius can be placed Sebastian Ziani de Ferranti, who is the subject of Mr. L. Randell's little pamphlet, one of a series dealing with British men of science and scientific institutions being published in English, Spanish and Portuguese for the British Council. Ferranti was born in Liverpool in 1864, and by the age of twenty was a manufacturer of dynamos, meters, transformers, etc. His early years were as astonishing as those of Edison, and to him more than to any other single individual is due the conception of the central super-power station generating electricity at high voltage, and its distribution over wide areas. He died in 1930, honoured throughout the engineering profession.

U.S. ANIMAL INDUSTRY

Introductory Animal Husbandry

By Prof. Arthur L. Anderson. Pp. xi+777. (New York: The Macmillan Company, 1943.) 20*s*. net.

BETWEEN Britain and the United States there are many differences in situation, and there is a corresponding diversity of outlook. Such differences are particularly marked in their respective livestock industries, and are historical and geographical in origin. Many of the American breeds came from the British Isles, but, in the place of stock in agriculture, in marketing arrangements, in food habits, there are great contrasts. The Englishman likes his breakfast bacon and Sunday joint, the American prefers porter-house steak, frankfurters, and (in moderation) 'Spam'. Britain is not self-sufficient in meat or animal feeding stuffs; livestock are an essential part of an intensive mixed agriculture; droughts are very inconsiderable affairs In America there are well-defined regions—cotton, wheat and corn belts; distances are important because dairying must be within a few hours' journey of population centres; the opening up of the interior by railways led to the packing-house system.

Prof. Anderson, in the scope of his book, has been guided by a survey by his publishers. It is designed as a text-book for students beginning a college course and for reference in vocational training. Sections of approximately equal length deal with beef cattle, milking cattle, sheep, pigs, and horses and mules. References are given only to readily accessible American publications.

Animal husbandry is defined as the breeding, feed-

ing and management of domestic animals; in introducing the subject, the author is less concerned with the animals than with their position in domestic trade and the economics of their production Thus, of ten chapters dealing with beef cattle, one is devoted to feeding and management and one to breeding: the remainder concern show-points and classes, marketing, meat grading, by-products and consumption, together with a brief historical introduction Extensive use is made of statistics from packing-houses, U S Department of Agriculture surveys and the like, dealing with such matters as seasonal fluctuations in market receipts and prices, percentage losses through injury in shipment by rail or road, average live-weights at slaughter-houses, milk distribution costs, and so on. A list of slaughter-house by-products and their disposition extends to incense and oriental medicine. In contrast, no details are given of the composition of feeding stuffs, nor is there any mention of the ruminant stomach (except as tripe) Similarly, though wastage in dairy cattle is very high, there is no discussion of the causes A curious omission is the absence of any reference to machine milking.

Housing, feeding and breeding are dealt with very briefly; a survey is given of usual practices and of economic aspects such as the price equivalents of corn and butterfat. Certain remarks on management have a very practical ring and a more than local application Two may be quoted here: "To top the market with beef steers is the fond hope of many cattle producers. . . . It is not always related to the most profit from the feeding enterprise"; and again, of sheep · "Not all pure-bred flocks exhibit sheep at shows and expositions, but fitting for sale is essential for selling to the best advantage. Likewise a pure-bred flock manager should have salesmanship ability. The showing of a flock at the livestock shows is a form of advertising . . ."

Prof. Anderson has aimed at the presentation of facts and the avoidance of matters of controversy. He has made much use of the findings of technical investigations. Some three hundred illustrations portray for the most part ideal breed types, industrial processes and price and population trends.

FUNDAMENTALS OF ASTRONOMY

From Atoms to Stars

By Dr Martin Davidson Pp. 188. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, 1944.) 15*s*. net.

BOOKS written with the view of meeting the enlarged interest in astronomy manifested by the ordinary individual in recent years have not been lacking on either side of the Atlantic. One of the latest, for British readers, bears the comprehensive, if somewhat inconsequent, title "From Atoms to Stars" and is from the pen of Dr. Martin Davidson, prominent among British astronomers for his wide theoretical knowledge of the subject. To quote from the preface, it is "intended to provide a general outline of the most up-to-date knowledge of the heavenly bodies and also to show the methods employed by the astronomer to derive their distances, sizes, masses, temperatures, etc. . . ."

It is the latter aim which gives to the book its distinctive character. As if to warrant the title, Chapter 1 is devoted to an account of the structure of the atom, according to present views, touching upon ionization, radioactivity, transmutation and allied phenomena The reader is thus prepared for a description, later in the book, of the sub-atomic processes by which the enormous output of radiant energy continuously emitted by the sun and the stars has been maintained for thousands of millions of years.

The succeeding chapters follow the general plan adopted in books of this type They deal in turn with the sun, the earth and the moon and phenomena relating to these bodies, next with the other members of the planetary system, including meteors and comets; and then five chapters are devoted to the stellar universe at large, in all its diversity of objects. Positional astronomy and star-configuration find no place in the book

Each chapter contains, in addition to ample descriptive and explanatory matter, much interesting detail of a kind not commonly found in non-technical books; while in a few cases a short bibliography is appended for the information of readers who may wish to enter more deeply into the subject.

Dr. Davidson's mathematical bent finds an outlet in the fulfilment of his promise to show how astronomers tackle their theoretical problems Many worked examples are incorporated in the text, most of them being in reality quite elementary, and some, perhaps, given at unnecessary length. This plan makes it difficult for readers to avoid the arithmetic even though they may wish merely to know the methods.

The final chapter contains a summary of various theories of the origin of the sun's planetary system, beginning with those of Kant and Laplace and concluding with several speculations of very recent date. The author is of opinion that none is really satisfactory.

A few typographical mistakes have slipped through the 'proof' stage—chiefly transposition of digits, of which the outstanding example is on page 132, where the value of a radian in degrees is stated to be $\pi/180$ instead of $180/\pi$. On pages 152, 153 "J. C. Adams" is a slip for Walter S. Adams. The director of Mount Wilson Observatory, California, is of course not to be confused with the ever-famous Prof J. C. Adams of Cambridge, who first demonstrated the existence of the planet Neptune, which was discovered later. It is surprising, also, to find Dr. Davidson giving renewed currency to the idea that the double high tides experienced at certain places—for example, at Southampton—are due to the successional arrival of the tidal wave by two different routes. This superficially plausible explanation has been shown by such authorities as Lord Kelvin and Sir George Darwin to be fallacious.

The book is illustrated with excellent photographs and many instructive diagrams. The style is pleasantly colloquial, though a feeling sometimes arises that the author, in compressing his material, is unconsciously stepping above the standard envisaged in his preface, and is taking for granted rather more astronomical knowledge than the average reader would be likely to possess. Nevertheless, to readers with ordinary scientific outlook, "From Atoms to Stars" can be heartily recommended as an authoritative, up-to-date outline of astronomy's wonderful achievements in the exploration of the infinities both of space and time. W. M. WITCHELL.

The Chemical Testing of Plant Nutrient Solutions

By G. S. Fawcett and Dr. R. H. Stoughton. Pp. 86. (Salisbury: The Tintometer, Ltd., 1944.) 8s. 6d.

THE routine testing of plant nutrient solutions is undoubtedly an important part of most investigations on the soilless growth of plants, and the genuine investigator must therefore be competent to carry out the necessary chemical operations. In this book, which is essentially a set of directions for carrying out the tests, the authors have succeeded in reducing the operations to as simple a form as possible, to give speed in analysis but yet to retain an accuracy sufficient for the purpose. This result has been achieved by employing, in all cases, colorimetric or nephelometric methods which must be used in conjunction with the 'All-Purpose Lovibond Comparator' and special standard colour and turbidity disks and comparator tubes. The chemical methods have been selected from text-books and the literature, and have been adjusted and critically tested under the conditions existing in plant nutrient solutions. They provide for the estimation of the major plant nutrients and the minor and trace elements manganese, iron, boron, copper and zinc. In some cases the methods are tentative and the authors hope to improve these. As with the simplification of many chemical methods, the applicability is restricted, in this case to plant nutrient solutions only; and the authors are emphatic that all details be adhered to closely. If this advice is followed, the novice can carry out some of the tests by himself, but others involve highly corrosive chemicals; and although ample detail and space is devoted in the early part of the book to the very elementary operations of handling chemical glassware and reagents, those who are inexperienced in chemical technique should, in the opinion of the reviewer, receive a short preliminary training.

This book, together with the specially designed apparatus, should prove a great help to experimenters in the soilless cultivation of plants. R. G. WARREN.

Symposium sôbre Raios Cosmicos, Rio de Janeiro, Agôsto 4–8, 1941

Pp. 180+19 plates. (Rio de Janeiro: Academia Brasileira de Ciências, 1943.)

IN this volume are reprinted, in English and French, the papers given at a symposium on cosmic rays held in August 1941 at Rio de Janeiro, under the auspices of the Brazilian Academy of Sciences, on the occasion of the visit of a group of American physicists led by Prof. A. H. Compton. The scope of the conference is indicated by the following titles selected from some twenty papers: (1) "On the Fluctuations of Cosmic Rays", by A. H. Compton; a discussion of the sidereal time variation of cosmic rays. (2) "On the Latitude Effect of Cosmic Rays", by B. Gross. (3) "Cosmic Ray Studies in the Andes of Southern Peru", by N. Hilberry and A. H. Hilberry. This paper describes the determination of the variation in the frequency of extensive showers with altitude, up to 5,850 m. above sea-level, for two different counter arrays, and affords an interesting proof that most extensive air showers are initiated by high-energy electrons. (4) "Cloud Chamber Photographs at High Altitudes", by D. Hughes. (5) "The Latitude Effect for the Hard Component of Cosmic Rays and Evidence as to the Nature of the Primary Radiation", by W. P. Jesse. (6) "The Influence of a Solar Eclipse on the Cosmic Ray Intensity", by Y. Monteux, G. Occhialini and M. D. Souza Santos. (7) "On the Ultra-Soft Component of Cosmic Radiation", by G. Occhialini and M. Schonberg. (8) "Showers of Penetrating Particles under 30 m. of Clay", by P. A. Pompeia, M. D Souza Santos and G. Wataghin (9) "On the Production of Mesotrons at High Altitudes", by E O. Wollan; this interesting paper gives the results of balloon flights to determine the *multiple* production of mesons as a function of altitude. No maximum is found up to a height corresponding to a pressure of 3 cm. of mercury.

It is unfortunate that publication of this report has been so long delayed, for much of the original work presented at the conference has been published in the meantime G. D. R.

Fitz-James O'Brien

A Literary Bohemian of the Eighteen-Fifties. By Prof. Francis Wolle. (University of Colorado Studies, Series B: Studies in the Humanities, Vol. 2, No. 2.) Pp. xi+309. (Boulder, Colo.: University of Colorado, 1944.) 2 dollars.

IN this painstaking and amply documented study Mr. Wolle follows the fortunes of a young Irishman who arrived in New York in 1852 with nothing but his wit and ready pen for luggage, and in the next ten years poured out a flood of ephemeral literature, reflecting the many facets of contemporary society. Such a chameleon could not escape the mid-nineteenth century interest in scientific discoveries and pseudo-scientific speculation. In his short stories, which rival in horror those of Poe, figure an invisible monster, a glass eye, robot killers, disembodied organs which continue to function normally, a swiftly revolving ball which is impervious to the force of gravity ("How I Overcame My Gravity"), a telepathist and, in his best-known work, "The Diamond Lens", a microscopist. This miscreant, by means of cold-blooded murder, produces the perfect lens, only to discover his ideal woman in a drop of water. Unable to make contact with her, he is doomed to watch her fade as the water evaporates. He goes mad.

Unfortunately science, in the hands of an inept surgeon, was unable to save O'Brien from the result of a pistol shot in the left shoulder, which he got while fighting with a New York regiment during the Civil War. After much needless suffering, a resection of the joint was decided on, tetanus set in, and this gifted but irresponsible Bohemian died at the age of thirty-three. Whether he would ever have fulfilled the fitful promise of his early years seems doubtful, and one wonders if it was worth while so meticulously to disinter his literary remains. They have something of a charnel-house smell, and one can only wonder at the mediocrity of a literary society in which their author ranked with the best. PHYLLIS HARTNOLL.

Studies on Immunisation

Second Series. With Appendices dealing with Antityphoid Inoculation, Chemotherapy, and Statistical and other Operations of Induction. By Sir Almroth E. Wright. (Researches from the Inoculation Department, St. Mary's Hospital, London, W.2, Vol. 4.) Pp. vii+256. (London: William Heinemann (Medical Books), Ltd., 1944.) 25s. net.

THIS volume contains selections from the published works of Sir Almroth E. Wright and his collaborators. The subjects include vaccine therapy, prophylactic inoculation against pneumonia, and other aspects of the field of immunity.

THE FORESTRY COMMISSION

THE FIRST TWENTY-FIVE YEARS

By Prof. E. P. STEBBING
University of Edinburgh

AS a result of the restrictions on imports and the heavy fellings made in the woods in Great Britain during the War of 1914–18, a Forestry Sub-Committee was set up to consider the question for the country as a whole, and its report, the Acland Report, was accepted by the Minister of Reconstruction and the Cabinet as a basis upon which to frame a Forestry Bill This Bill was passed in 1919

The idea underlying the framing of the Bill was the necessity of making provision, against a possible future war, for a three years supply of timber and pit wood in the country. The estimated area to furnish this amount was laid down as 1,770,000 acres. This area was to be planted in a period of eighty years at a total cost of £15,000,000. During the first ten years, for which the Bill provided, an area of 250,000 acres was to be planted at an estimated cost of £2,872,500.

The chief work, therefore, of this new State Department was to bring into being a State ownership of forest land and to afforest all suitable parts of these areas; to create, in fact, national forests, a type of ownership of woods which had never previously existed in Britain. For the so-called State forests, the Dean, New Forest, and so forth, were originally, and had come down to us solely as, the personal property of the Crown. This pioneer work of acquiring land, draining, clearing, fencing and raising the plants required in nurseries and having the requisite number ready each year for the estimated areas to be planted up was by no means so easy as had perhaps been anticipated by some of the most ardent adherents of the new departure. Further, the recruitment of the indispensable trained staff proved another difficulty. Under the Forestry Bill the Commission was to receive annual grants to cover its expenditure. In forestry, a type of work necessitating the longest views, since trees do not grow to maturity in the brief space of agricultural crops, a departmental budget based on stability is indispensable The financial crises which supervened between 1920 and 1931 had their automatic effects on checking and upsetting the annual planting plans so rigidly laid down in the Acland Report, one of its chief failings, and consequently the activities of the new department. In this connexion and owing to the inexperience of the staff, unnecessary waste was possibly incurred at these set-backs. Large numbers of plants were actually burnt in the great nurseries owing to the cutting down of the yearly planting programme; whereas there is no doubt that they could, with considerable advantage, if only in the interests of the taxpayer, have been offered at the cost of carriage to private owners of woods, as is so commonly done in Europe and, in fact, is at the present time being done in certain parts of the British Empire overseas

In this connexion there was another serious drawback to the Acland Report, to which the Commission adhered so rigidly. The report was based almost solely on the annual planting of conifers. The valuable British broad-leaved species or hardwoods were almost entirely neglected. In fact, in parts of Britain where poorly managed areas of coppice with standards were purchased with the estate acquired by the Commission, such was the conifer obsession that these areas after being cleared were planted with conifers; this often resulted in a heavy cleaning expenditure for a number of years to prevent the resultant coppice shoots—the natural tree flora of the locality—from smothering and killing the expensively raised and planted conifers.

It will be readily admitted that the new department had to show results, or it would have risked suppression at the hands of a lukewarm Government, House of Commons and public; and conifers are easier to raise and plant and grow more quickly than hardwoods. Moreover, the bulk of the land acquired by the Forestry Commission was conifer land.

The acquisition of the necessary land did not prove so easy. For one thing, the agricultural parts of an estate together with buildings and so forth had to be acquired; since a depreciation in values would result if only a specified portion of an estate were sold.

In the past twenty-five years the Commission has acquired approximately 1¼ million acres, of which half a million acres has been afforested and a quarter of a million acres remains to be planted. The rest of the land is either unproductive, above the present possible plantable elevation, and mountain tops, or land which is agricultural in its broadest sense and therefore does not fall within the province of the forester. These land areas now belonging to the State, that is, the public, are spread over 263 forests, of which 102 are in England, 39 in Wales and 122 in Scotland. It was foreseen that in these at present out-of-the-way-regions it would be necessary to make provision for accommodation for permanent forest workers. A programme was therefore prepared for the building of forest holdings, that is, houses each with an acre or two of land to produce vegetables and so forth; 1,500 of these holdings have been established during the period.

In England and Wales an area of 625,505 acres of land has been acquired, of which 464,178 acres is plantable land, the rest being described as agricultural holdings, nurseries, unplantable, etc. The areas planted were 276,898 acres of unafforested land and 49,102 acres of acquired woodland (the New Forest, Forest of Dean, etc., made over to the management of the Commission). The chief species used in the re-afforestation work and in planting in the acquired woodlands were Scots and Corsican pine, European and Japanese larch, Norway and Sitka spruce, Douglas fir (very popular in the early years of the Commission), oak and beech. In Scotland the total area acquired has amounted to 627,000 acres, of which 316,000 acres is plantable. The area planted has amounted to 163,000 acres, the species used being Norway and Sitka spruce, about 53 per cent; Scots and Corsican pines, about 26 per cent; European and Japanese larches, about 11 per cent; others, 10 per cent.

On the subject of private forestry, the Commission states that grants given for planting in private woodlands have been made in respect of 145,000 acres, the grant being £2–£4 per acre. Land owners, while gladly acknowledging this assistance, complained that since practical assistance by the Commission was not available, the planting-rate on estate woodlands was not much more than 6,000 acres a year, as compared with nearly double in the early years of the present century; although after

the heavy war fellings during 1914–18 the planting-rate should have been greatly accelerated In 1914 some 97 per cent of the woods in Great Britain, amounting to 2½ million acres, were privately owned The Commissioners claim, nevertheless, that advice on many aspects of forestry has been given to private owners. But it must be admitted that the private owners had a strong case when they maintained, first, that the new and very young State forest staff had a full-time job, increasing with the passing years, and that little time was therefore available for advice to the private owner. More than this was, however, involved; the training and experience of the staff, with no long tradition and no precedents behind them, were not always adequate to enable them to advise in the management of estate woodlands, especially the smaller ones, which presented a whole set of quite different and often very complex problems.

An interesting side-line of the work of the Commission, but a natural development, as it turns out, is the creation of three national parks on the State-owned forest land, and two more are to follow The controversies which have taken place over the question of the afforestation of beauty spots were probably almost inevitable in a country such as Britain, with a population which knew nothing about forestry or its objectives and had lost all forest sense. That the young department may have blundered in some cases is scarcely to be wondered at. But the ignorance of the public on the subject was equally apparent.

Towards the end of the period here dealt with, the Commissioners have prepared two White Papers on post-war forestry. The first of these has had a first reading in the House of Commons

The present Commissioners were appointed by the King, and their average length of service is now ten years. The first chairman and the man who may be said to have made the Commission was the late Lord Lovat, 1919–27; followed by Lord Clinton, 1927–29, Sir John Stirling Maxwell, 1929–32; and then Sir Roy L. Robinson, 1932 to date Mr. Robinson was the technical commissioner to Lord Lovat and remained in the Commission in this capacity until his appointment as chairman. In the first few years, the Commission consisted chiefly of landed proprietors—to this reason perhaps may be attributed the failure to start replanting all the cut-over areas of 1914–18, since they might have been accused of helping themselves. On the other hand, it is conceded that it was due to Lord Lovat as chairman that the Commission survived the financial crises which supervened so quickly after its birth Latterly, the Commission has had a far greater political and House of Commons flavour in its composition.

A point often raised during the past twenty-five years was the irresponsibility of Ministers and the Cabinet for the progress of forestry in Great Britain. The Forestry Commission was represented by a Commissioner, a member of the House of Commons, who acted as its spokesman. Many considered that this was far from effective; that it placed the afforestation programme of the country, a purely public matter, in constant jeopardy; that, in fact, either the business was sufficiently important to deserve the attention of, and responsibility for, a Minister of State; or the Government should give its reason for leaving the matter in the hands of a more or less autocratic authority control led solely by the Treasury. This may be said to have been the practice at the close of the twenty-five years work. In the House of Commons on February 15 it was announced that the Minister for Agriculture and the Secretary of State for Scotland will in future be jointly responsible for forestry, the Forestry Commission being retained as an advisory body with executive functions (see p 311).

One of the present troubles the staff of the Forestry Commission have had to deal with has been fire damage, always a serious danger with large areas of young conifers Considerable research work into certain problems in connexion with little-known aspects of the work facing them was undertaken in the early years; for example, investigations into seed qualities, and the best regions to obtain the seed from, since so many of the species being used in the new work were exotics, nursery investigations on methods of sowing, soils, rate of growth and so forth, manuring, diseases in the nursery, both fungal and insect attacks, etc., including climatic factors, brought forth excellent results in some cases; as also the studies made of the soil flora in different regions, and growth statistics. More spectacular and easier to understand were the experiments carried out with the object of learning how to plant areas of peat land often of some depth, of which a not inconsiderable proportion of the land acquired by the Commission consisted. Sufficient here to say that great success was attained in some regions by the employment of tractor ploughing. The great increase in mechanization in connexion with farm implements of all types enabled the Commission to devise, and the makers to construct, a tractor plough of such power that areas of deep peat, hitherto beyond the ability of man to cultivate in any way, are now turned up into deep furrows and ridges, enabling drainage to be given to the area while the young trees are planted on the ridges Continually increasing areas of such lands are being afforested, and it is a sight well worth visiting, whether from a scientific or popular point of view

Other experiences likely to be of considerable interest to the scientific man are the investigations which have had to be taken up at short notice in connexion with pests In the early years, great hopes were placed on the Douglas fir; but a *Chermes* appeared on it and threatened young plantations wholesale. The *Hylobius* weevil was a well-known pest, but although in Prussia chiefly confined to Scots pine, the extended work of the Commission showed that the weevil would attack several of the exotic coniferous species being used. The interest of this work lies in what is becoming a recognized factor in planting work, whether agricultural or forestry, that a large and sudden extension on a countryside will invariably be accompanied by an increase in local pests, and not uncommonly the appearance of new ones.

Looking back over the past twenty-five years, it may be said that the Forestry Commission and its officers are to be congratulated on the work which has been accomplished in spite of often difficult obstacles. The public now participate as owners in a forestry estate which with adequate support, both financial and otherwise, will form a great asset to Great Britain, always provided that the growth of the hardwoods in their respective regions is not neglected, for some of them produce the finest timber of the temperate zone, while their beauty has made English scenery as enchanting as any the world can show.

NICOTINAMIDE METHOCHLORIDE AND ITS FLUORESCENT DERIVATIVES

By DR. P. ELLINGER

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THE methylation of pyridine in the animal body was observed by His[1]. When he showed that pyridine was converted to N-methyl pyridinium hydroxide and when Ackermann[2] found that ingested nicotinic acid was partly eliminated as trigonelline, these observations were at that time mainly of theoretical interest They became of practical value, however, when nicotinamide was shown to be a constituent of the coenzymes I and II by Warburg and Christian[3], Warburg, Christian and Griese[4], and v. Euler, Albers and Schlenk[5], and their significance became obvious when Knight[6] demonstrated the importance of nicotinic acid as a growth factor in bacteria, and Elvehjem, Madden, Strong and Woodley[7] showed the curative effect of nicotinic acid in canine black tongue and suggested its identity with Goldberger's *PP* factor, this fact was verified by numerous investigators It was of considerable interest, therefore, when Najjar and Wood[8] published their discovery that a whitish blue fluorescent substance was present in the urine of normal subjects and was increased in amount after the ingestion of nicotinamide and other related compounds.

The fluorescent material was demonstrated when a 'Decalso' adsorbate of urine was eluted with potassium chloride solution and the solution was made alkaline and extracted with butanol. The butanol extract showed fluorescence when exposed to the light of a mercury vapour bulb filtered through a Wood glass filter In an attempt to identify the substance a large number of pyridine derivatives were examined, but none of them revealed the characteristic fluorescence when tested under similar conditions. The fluorescence spectrum in butanol was determined; a number of observations were made upon the stability and solubility of the fluorescent substance in butanol and a rough method of assay was devised by matching the fluorescence intensity of the butanol extract against that of a standard solution of quinine sulphate. Somewhat later, Najjar and Holt[9] described a second substance that possessed a violet-blue fluorescence which became visible when the potassium chloride eluate of a urinary 'Decalso' adsorbate was extracted with butanol without adding alkali. This substance was called F_1 by the authors, while the substance observed after alkalinization was called F_2.

The pigment F_1 was found in the urines of patients in the acute stages of pellagra and of black tongue dogs in which F_2 was more or less reduced A number of theories were put forward about the nature of F_1 and F_2 and their function, and it was suggested that F_1 might be responsible for the photosensitivity of pellagrins. The fluorescence of F_1 was also characterized by its emission band The administration of nicotinic acid to pellagrins and black tongue dogs caused a prompt reduction of F_1 and reappearance of F_2[10,11]. The nature of F_1 is still unknown. A number of pyridine and pyrazine derivatives were tested for their power to increase F_2; but nicotinic acid, nicotinamide and nikethamide alone were found to be active. These compounds were also known to be active in the cure of pellagra.

A violet fluorescent substance was reported by Singal and Sydenstricker[12] in the urine after ingestion of pyridoxine The pigment is said to be present in the neutral butanol extract of a potassium chloride eluate of a urine adsorbate on 'Decalso'. Ellinger and Coulson[13] were unable to confirm this observation, but Huff and Perlzweig[14,15] succeeded in isolating the fluorescent material and identified it as 4-pyridoxic acid.

An attempt was made to use the elimination of F_2 by animals and man for the estimation of nicotinamide and related compounds in foodstuffs at the suggestion of Dr B. S Platt For this purpose dogs, ferrets and human volunteers were calibrated with nicotinamide and a preliminary method giving comparable but not absolute values was devised for the quantitative assay of F_2 in urine[16,17].

In order to develop an assay method providing absolute results, it was necessary to elucidate the chemical nature of F_2. Attempts were made, therefore, to concentrate and purify the fluorescent pigment contained in the butanol or *iso*butanol extracts[18] The purification was carried out with the aid of the ultra-violet absorption spectrum. The absorption spectrum, the fluorescence spectrum and the behaviour of the substance towards reducing agents, alkali and acid, were so similar to those of thiochrome that F_2 was thought to be a mixture of thiochrome and a whitish fluorescent substance. Differences in the adsorption on 'Decalso' of F_2 and thiochrome at different pH's later proved that this conclusion was incorrect[19].

Two papers on the chemical nature of F_2 were published simultaneously by Najjar, Scott and Holt[20], and by Huff and Perlzweig[21]. The former authors concentrated and purified F_2 and examined the properties of the concentrate. They observed its fluorescence in presence of alkali and acid, and recorded its stability towards oxidation; they observed the irreversible formation of a violet fluorescence after treatment with alkali and potassium ferricyanide, of a yellow pigment with green fluorescence after treatment with alkali and acetone, and of a non-fluorescent orange-red pigment after the addition of sulphanilic acid. These workers proved that F_2 is a pyridine compound by producing a positive cyanogen bromide test after alkaline hydrolysis. They realized that there were similarities between F_2 and the reduction products of N-methyl nicotinamide, but were unable to identify F_2 with one of these products on account of certain discrepancies.

Huff and Perlzweig[21] showed that animal species which were known to methylate ingested nicotinic acid eliminate increased amounts of F_2 after the ingestion of nicotinamide, while rabbits, which are unable to perform this methylation, do not eliminate F_2 after nicotinamide dosage. They claimed to have established the identity of F_2 with synthetic N-methyl-nicotinamide on the basis of the identity of the melting points and mixed melting point of the respective picrates They concluded that "F_2 thus appears to be a N-methyl nicotinamide or a labile precursor which yields this compound in the course of isolation". Somewhat later[22], they stated: "A crystalline substance was isolated from human urine after dosage with nicotinamide. From comparison with synthesised N[1]-methyl-nicotinamide chloride in regard to content of nitrogen, chloride and nicotinic acid, and in regard to the absorption spectra, fluorescence, and the melting point of the picrate the two

substances were found to be identical. This establishes the identity of the fluorescent substance, F_2, previously described by Najjar, Holt, and their collaborators". They proved that most of the trigonelline found by earlier methods in animal urine after nicotinamide ingestion was in reality nicotinamide methochloride, a fact already made probable by Sarrett[23].

Ellinger and Coulson[19,24] also attempted to determine the chemical nature of F_2, and examined *iso*butanol extracts that had been evaporated at 60°. The material revealed the presence of at least five different fluorescent substances which could be separated chromatographically or by fractionated sublimation. When the concentration and purification of natural F_2 or of the fluorescent derivative of synthetic nicotinamide methochloride was carried out at room temperature, however, chromatographic adsorption analysis revealed the presence of only two fluorescent compounds, which were called F_{2a} and F_{2b}.

Up to that time, it was generally believed that F_2 was eliminated in the urine as a fluorescent pigment. This erroneous conclusion was responsible for much unnecessary work and gave rise to considerable confusion, which with certain workers still persists. Keresztesy[25], for example, still speaks of the fluorescent F_2 appearing in human urine. Ellinger and Coulson[19] showed that when examined in the light of the 366 and 311 mμ mercury lines, neither the potassium chloride eluate of an adsorbate of urine on 'Decalso' nor that of an aqueous solution of nicotinamide methochloride is fluorescent, but that both become slightly fluorescent when made alkaline and that the fluorescence becomes more intense when the alkaline substance is extracted with *iso*butanol. Huff and Perlzweig[26] discriminated for the first time between the fluorescent F_2 and its non-fluorescent precursor in a paper published in 1944, in which they claim that their original investigation was concerned with the non-fluorescent precursor of F_2 and not as indicated in their earlier publications[21,22] with the fluorescent derivative. The comparison by Ellinger and Coulson[19,24] of a number of properties of the non-fluorescent precursor of F_2 and of synthetic nicotinamide methochloride, such as melting points of picrates and mercury iodides, absorption spectra, behaviour towards treatment with alkali and *iso*-butanol, absorption and emission spectra of the fluorescent derivatives showed the complete identity of the two compounds. The only difference observed was that in the melting points of the aurates. It is to be noted, however, that aurates with different melting points and gold content were observed for trigonelline by Jahns[27], and, therefore, a difference of this kind cannot be accepted as indicating that the two compounds are different. A different gold content was observed, indeed, for the aurates of the natural precursor of F_2 and the synthetic nicotinamide methochloride, and three aurates could be obtained from the latter differing in colour, crystal structure and melting point (Ellinger[28]).

The careful analysis of the behaviour of both the natural non-fluorescent precursor of F_2 and the non-fluorescent nicotinamide methochloride after treatment with alkali and *iso*butanol revealed the following facts. In aqueous solution, when examined in the beam of the 366 mμ and 311mμ mercury lines, both substances are non-fluorescent. After the addition of alkali a weak whitish-blue fluorescence develops which can be extracted with *iso*butanol and increases as much as 400 times in intensity when in *iso*butanol. The absorption spectra of the non-fluorescent precursor of F_2 and of nicotinamide methochloride show maxima at 264 mμ, recorded by Huff and Perlzweig[22] for F_2 and nicotinamide methochloride. The absorption spectra of F_2 and of the synthetic nicotinamide methochloride derivative obtained after alkali and *iso*butanol treatment showed maxima at 358 mμ. The addition of alkali to the precursor of F_2 or synthetic nicotinamide methochloride in aqueous solution causes practically no change in light absorption.

These facts lead to the conclusion that alkalinization causes a change in the nicotinamide molecule By analogy with the findings of Hantzsch and Kalb[29] and of Decker and Kaufmann[30], a migration of the OH group from the pyridine N to one of the pyridine C atoms with simultaneous loss of one double bond in the pyridine nucleus and formation of carbinols was suggested. The low fluorescence intensity and the practically unchanged absorption spectrum in aqueous solution after alkalinization showed that in water the equilibrium between the quaternary pyridinium base and the carbinols was in favour of the former, while the high fluorescence intensity and the almost complete change of adsorption spectrum in *iso*butanol indicates a reversed equilibrium in the latter solvents.

Adsorption on aluminium oxide of the purified F_2 as well as of the fluorescent derivative of nicotinamide methochloride and elution with *iso*butanol and methanol, respectively, revealed the presence in F_2 of two fluorescent compounds, F_{2a} and F_{2b}, each possessing different absorption and emission spectra. The form of their absorption spectra and the similarity with dihydro derivatives of nicotinamide described by Warburg and Christian[3], Warburg, Christian and Griese[4], and Karrer, Schwarzenbach, Benz and Solmssen[31] lead to the conclusion that F_{2a} was probably the γ-carbinol, and F_{2b} an α-carbinol of N-methyl dihydronicotinamide. In the light usually employed, which is derived from a mercury vapour lamp filtered by Wood glass, the emission spectrum of F_2 is almost identical with that of F_{2b}, since the primary light consists mainly of the 366 mμ lines which are strongly absorbed by F_{2b} but very little by F_{2a}.

Perlzweig, Bernheim and Bernheim[32] made the important observation that nicotinamide but not nicotinic acid is methylated *in vitro* by liver, but not by kidney or muscle slices of rats. Usually, but not always, this methylation of nicotinamide is increased by addition of methionine or choline. The methylation process requires the presence of oxygen and intact living cells.

Further observations on the nature of F_2 were published by Najjar, White and Scott[33], and by Najjar and White[34,35]. In the last two communications[34,35], Ellinger and Coulson's[19] original observations that the metabolite of nicotinamide was non-fluorescent and became the fluorescent F_2 by treatment with alkali and *iso*butanol was confirmed, whereas in the earlier paper[33] no discrimination was made between F_2 and its non-fluorescent precursor. Najjar, White and Scott[33] describe the preparation of a purified F_2 concentrate as a waxy material from which crystals were obtained by treatment with ethyl acetate, water, or methanol. A number of properties of these crystals were described. The absorption maximum of the fluorescent F_2 is described as at 264 mμ, which corresponds to that found by Ellinger and Coulson[19] for the aqueous non-fluorescent precursor; the maximum for the fluorescent F_2 *iso*-

butanol solution was found by Ellinger and Coulson to be at 358 mμ. Alkaline hydrolysis of the crystalline material afforded a product giving a cyanogen bromide reaction. Najjar and co-workers[33,34,35] accept the conclusions of Ellinger and Coulson[19] that the development of fluorescence from the non-fluorescent nicotinamide methochloride or the precursor of F_2 by alkalinization and treatment with butanol is due to a rearrangement of the quaternary base into a carbinol, but they believe that F_2 is a carbinol-*iso*butanol-ether. This conclusion is based on the following facts: (*a*) that the fluorescence of the alkaline aqueous solution is greatly increased by the addition of small amounts of *iso*butanol enough to saturate the aqueous layer, but insufficient to cause a separation of the two layers; (*b*) that the fluorescence intensity of the *iso*butanol layer increases while standing. The carbinol-butanol-ether is said to break down when evaporated to dryness. An elementary analysis of the crystals yielded values for nitrogen which correspond to about half the amount theoretically required.

The evidence for F_2 being a carbinol-butanol-ether would appear to be inadequate, since the increase of fluorescence on addition of *iso*butanol to the alkalized aqueous nicotinamide methochloride solution is fully explained by the fact that a considerable amount of *iso*butanol favouring the carbinol phase is dissolved in water. This increase in fluorescence intensity is observed when a number of solvents of F_2, such as methanol, ethanol, amyl alcohol, ethyl acetate (some of them being miscible with water) are added to the alkalized aqueous solution of nicotinamide methochloride or of the precursor of F_2, but not when organic solvents are added which do not dissolve F_2, such as ether, petrol ether, pentane, chloroform (Ellinger[28]). The increase in the fluorescence intensity on standing is explained by the fact that the rearrangement of the quaternary base into the carbinol, induced by the equilibria in aqueous and butanol solutions and the relative solubility of the carbinol in the two layers, is a slow process. Under the conditions used in the assay method as described by Coulson, Ellinger and Holden[36], maximum fluorescence of the butanol layer is reached after thorough shaking for five minutes.

There is one experimental fact against the acceptance of the idea that F_2 is a carbinol-butanol-ether. The pigment F_2 can be developed by treating the aqueous alkaline solution of nicotinamide methochloride or of the precursor of F_2 with ethyl acetate in place of butanol[28]. It seems improbable that ethyl acetate is able to form a carbinol-butanol-ether or a corresponding ether with the carbinol. The fluorescence in the ethyl acetate layer is less intense than in butanol owing to a lower partition coefficient (Ellinger[28]).

Najjar and co-workers[33,34,35] stress the apparent discrepancy between nicotinamide methochloride and the non-fluorescent precursor of F_2, and employ for this purpose the findings of Coulson and Ellinger[24] that different aurates are formed from the two products. However, as has already been pointed out, aurates with varying gold content are formed also from trigonelline. Najjar and White[35] produce additional evidence in support of their conclusion that the two substances are dissimilar. The precursor of F_2 is said to show a weak bluish fluorescence, and the urinary precursor of F_2 is said to differ when different anti-pellagric agents are ingested. Reineckates obtained from urinary eluates after the ingestion of nicotinic acid and of nicotinamide are also said to show significant differences in melting points. No crystalline picrate was obtained from the precursor of F_2 recovered after nicotinic acid administration. The weak fluorescence of the urinary precursor of F_2 would appear to contradict the findings of Ellinger and Coulson[19] and of Huff and Perlzweig[26]. The absence of any specific details of the exciting beam used by Najjar and White[35] makes it necessary to assume that Wood glass filtered mercury light was used, that is, a light consisting of about 90 per cent of the 366 mμ and 10 per cent of the 311 mμ lines If the absorption spectrum of the precursor of F_2 as found by Ellinger and Coulson[19] and by Huff and Perlzweig[12] for 'F_2' is correct, then the precursor of F_2 cannot be 'fluorescent' under the conditions of the experiment, since the 366 mμ and 311mμ lines are not absorbed by the aqueous solution. The fluorescence observed by Najjar and White is probably due to impurities. Picrates possessing identical melting points have been found by Ellinger[28] from the precursors of F_2 after ingestion of nicotinamide, nicotinic acid, and nikethamide by a human subject. The occurrence of two different Reineckates may be due to the same cause as that of two different aurates. There is at present no evidence for the non-identity of the urinary precursor of F_2 and nicotinamide methochloride and for different F_2 precursors after the ingestion of nicotinamide and nicotinic acid.

Najjar and co-workers[20,37] have attributed a considerable biological activity to nicotinamide methochloride. It is considered to be a growth factor for *E. coli* and *H. influenzæ* and an efficient agent in preventing and curing nicotinamide deficiencies in hamsters and dogs

The interference with the estimation of aneurin by the thiochrome method by the formation of a bluish fluorescent derivative of the nicotinamide methochloride simultaneously present during the treatment with alkali and ferricyanide was observed by Najjar and Ketron[38], and a method was devised to avoid this error. This bluish fluorescent pigment was called F_3 by Coulson[39], who considered it to be most probably a N-methyl pyridone derivative of nicotinamide. It seems probable that the same substance was obtained by Ellinger[28] from F_{2b}, but not from F_{2a}, by treatment with alkaline ferricyanide. Coulson[39] also devised a method for simultaneous determination of aneurin and nicotinamide methochloride.

In addition to the earlier methods, three quantitative procedures for the estimation of nicotinamide methochloride have been devised, by Huff and Perlzweig[40], by Coulson, Ellinger and Holden[36], and by Najjar[41]. With the help of these improved methods, a clearer insight was gained concerning the metabolism of nicotinamide in normal persons and its changes in certain diseases (Ellinger and Coulson[13]). Only 10–15 per cent of ingested nicotinamide is eliminated as nicotinamide methochloride in the urine by normal persons after a single ingestion; thus it must be emphasized that about four-fifths of the ingested nicotinamide cannot be accounted for[36]. It remains to determine whether nicotinamide methochloride is the only metabolite of nicotinamide in man and animals which methylates pyridine derivatives, or whether other metabolites such as trigonelline can be found, especially after the ingestion of nicotinic acid.

Ellinger and Coulson[13] examined the effect of the ingestion of nicotinamide, nicotinic acid and other

nicotinamide derivatives on the daily elimination of nicotinamide methochloride, studied the intrinsic and extrinsic factors influencing this elimination and discussed the mechanism of the formation of nicotinamide methochloride. From the relation of the eliminated nicotinamide methochloride to the dietary nicotinamide intake, they suspected the presence of an extra-dietary source of nicotinamide This supposition was proved to be correct by Ellinger, Coulson and Benesch[42,43], who showed that a considerable proportion of the human requirements of nicotinamide can be due to the production of this substance by the intestinal flora, a fact which throws new light on the etiology of pellagra and other nicotinamide deficiencies Nicotinamide elimination in pellagra was studied by Holt and Najjar[44], Roberts and Najjar[45] and Ellinger and Benesch[16]; they found lower elimination of the F_2 precursor in pellagrins than in healthy persons, both untreated and after single and repeated administrations of nicotinamide A change of these 'saturation curves' was also observed in certain liver diseases (Ellinger and Benesch[46]). Evidence was obtained that ulcerative gingivostomatitis was not due to a nicotinamide deficiency (Coulson, Ellinger and Smart[47]).

'Fluorescence' throughout this paper always means fluorescence in the visible region produced by the primary light used usually for this purpose, namely, long-wave ultra-violet, especially the 366 $m\mu$ and 311 $m\mu$ mercury lines It is quite possible that aqueous solutions of nicotinamide methochloride emit fluorescence in the ultra-violet region when excited with rays of about 260 $m\mu$. To investigate this point more complicated instruments, a quartz monochromator and an ultra-violet spectrograph are necessary. When fluorescence is mentioned, the absorption spectrum of the substance in question and the wave-length of the exciting beam should be given to explain whether under the conditions of the experiment fluorescence can be produced. To characterize the fluorescence qualities of a substance the 'fluorescence efficiency', that is fluorescence intensity per absorbed light quant (Wawilow[48]), should be given in addition to the exciting wave-lengths and the absorption spectrum. Since absolute values of the fluorescence efficiency are difficult to obtain, it is advisable to relate the measured fluorescent intensity when half the exciting light is absorbed to that of an aqueous quinine sulphate solution of the same molar concentration under the same conditions as standard. The knowledge of the fluorescence efficiency makes it possible to judge whether changes of fluorescence intensity which occur frequently, for example, by alterations of pH, are due to a shift of the absorption band or to a change in fluorescence efficiency.

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'RUBBER ACID' DAMAGE IN FIRE HOSES

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IN a brief reference, Crosby, Fiske and Forster[1] mention that a common cause of hose failure in rubber-lined fire hoses may be due to sulphuric acid formed from sulphur present in hoses when these are not properly dried. Such damage, apparently, was almost unknown in Great Britain before the War, but has recently been much in evidence According to Phillips[2], 'rubber acid' is produced, and its damage observed chiefly in fire stations which lack adequate draining and drying facilities. It would appear to affect primarily, if not exclusively, rubber-lined fire hose.

When rubber-lined hose is stored after use, without preliminary drainage and drying, there is invariably left in it a certain amount of water, and when such hose is examined during storage, it is found to contain a liquid; commonly the amount is no more than a quarter of a pint. This liquid is not infrequently discoloured brown. It is often slightly turbid and

markedly acid; the degree of acidity tends to increase with duration of storage. On examination the acid proves to be sulphuric.

When rubber acid is accidentally spilt over the canvas surface of the hose, or over any other cellulosic fabric, rapid tendering occurs, a process which becomes accelerated with the drying off of the fabric. When spilt over a concrete floor the rubber acid may cause corrosion of the floor surface and evolution of carbon dioxide gas bubbles.

Phillips[2] has given some data illustrating the importance of the damage caused by rubber acid to the hose, and as an immediate remedy advocated thorough draining of the hose after use. In a subsequent communication[3], Phillips *et al.* describe an examination of three hundred hose bursts, representing damage throughout Great Britain. More than 50 per cent of these bursts were due to rubber acid damage. They record also that rubber-lined hose of British, Canadian and American origin are equally subject to the fault, and that the concentration of sulphuric acid found in the hose liquor may reach a figure of about 1 per cent.

Phillips *et al.* state that the opinion has been advanced that acid production is due to the inclusion in the hose rubber of an excessive amount of free sulphur, which in the presence of water and air becomes oxidized to yield sulphuric acid. However, the well-known resistance of elemental sulphur to auto-oxidation at atmospheric temperatures seemed, on the face of it, to preclude this explanation. On the other hand, micro-organisms had been observed in numerous samples of hose liquid, and since there is well-established evidence to show that in the presence of certain micro-organisms, elemental sulphur can be oxidized to sulphuric acid at atmospheric temperatures, it was logical to keep this possibility in view and to ask the Chemical Research Laboratory to examine it.

The initial samples of hose liquor were drawn under aseptic conditions from rubber-lined hoses from three fire stations in the Kingston (Surrey) district.

Details of these samples are given in Table 1.

TABLE 1.

Station	Sample No	Appearance of liquid	Reaction of liquid to litmus	*p*H of liquid	Date hose last used
A	1	Colourless	Neutral	7·1	2 days previously
	2	Faintly discoloured and turbid	Neutral to only slightly acid	7·0	2 days previously
	3	Strongly yellow and turbid	Acid	1·0	At least 6 months
B	4	Colourless	Neutral to only slightly acid (about ½ gallon)	7·0	At least 7 days
	5	Colourless and somewhat turbid	Neutral to only slightly acid (about 1 quart)	7·1	At least 7 days
C	6	Brown	Acid	1·0	At least 4 months

The presence of micro-organisms in the various samples was confirmed both by direct microscopic examination and by cultivation on ordinary nutrient agar, wort agar and thiosulphate agar, the latter being a medium free from organic substances and recommended by Waksman[4] for the cultivation of sulphur-oxidizing bacteria.

The microflora taken from the six samples of rubber acid and found capable of growth on ordinary nutrient agar comprised several forms, all of them with their natural habitat in soil and water. Their numbers ranged between two and fifteen million cells per ml. of hose liquor, except in sample 6, where they were completely absent. The highest number occurred in sample 2. None of them was of a type capable of oxidizing elemental sulphur.

On wort agar only four types of fungi developed: a black fungus so far unidentified; another with white mycelium, possibly a *Cephalosporium* species; a black *Dematium* species and a pink *Torulopsis* species. Their numbers did not exceed 70,000 cells per ml. in any of the rubber acid samples, and were no more than 20 per ml. in sample 6.

The *Cephalosporium* species was found in samples 1 and 2; the unidentified fungus in samples 3, 4, 5 and 6; the *Dematium* species in samples 1 and 4 and the pink *Torulopsis* species in sample 4. Only the black fungus, therefore, could have been associated with acid production. However, since it did not appear on any of the thiosulphate agar media, it is unlikely, to say the least, to have played a major part in sulphur oxidation.

The organisms which grew on the thiosulphate agar were restricted to no more than five types, all of them short, non-spore-forming rods. Their numbers in the various acid samples were very much of the same order, ranging from 13 to 19 million cells per ml. of hose liquor, except in sample 6 where only 5 million cells were counted.

Each of these types was tested for its sulphur-oxidizing power by inoculating it into a medium containing inorganic salts and free sulphur. On this medium only two of them, isolated from hose liquor samples 3 and 6, grew rapidly, and in less than a week rendered the liquid turbid and acid, with a drop in the original reaction of the medium from *p*H 4·6 to *p*H 1. The acid produced was identified as sulphuric acid. Of the remaining types of short rods growing on thiosulphate agar, it should be mentioned that they grew well also on ordinary nutrient agar. Those from liquors 3 and 6, which produced acid from elemental sulphur, did not do so.

The remaining four samples of hose liquid, from which sulphur-oxidizing bacteria had not been isolated by the direct method employed, were inoculated into an inorganic liquid medium containing free sulphur. It was suspected that the failure to isolate sulphur-oxidizing bacteria from these samples might have been due to their containing too few cells. By introducing the original hose liquors into a medium specially adapted for the growth of sulphur-oxidizing bacteria, it was hoped to increase their numbers and thus to facilitate their isolation. However, after incubation of the inoculated special media for 14 days at 30° C. only one of these, that inoculated with hose liquor No. 4, gave rise to acid. From this sample it was possible to isolate typical sulphur-oxidizing bacteria. The others remained unchanged in reaction and showed no growth of micro-organisms. It is probable, therefore, that these samples Nos. 1, 2 and 5 had not contained the organisms looked for.

It had been possible, therefore, to isolate sulphur-oxidizing bacteria from only 50 per cent of the hose liquors examined, implying either that these organisms may not be necessary for acid formation, or that these samples of liquors in which the organisms had

not been found, and presumably had not been present, would have failed to become acid in any event. On the available information it is not possible to decide which of the two alternatives is correct, though one deduction that can be made from the collected data seems to point in favour of the latter explanation.

The inconclusiveness of the results thus far obtained, which incidentally were unlikely to be improved upon by an analysis of further samples of hose liquor, made it desirable to test the hypothesis of a microbiological origin of rubber acid from a different angle, and to establish whether water introduced into rubber-lined hose would invariably become acid, if it contained sulphur-oxidizing bacteria.

An experiment was set up for this purpose in which tap water containing sulphur-oxidizing bacteria was introduced into sections of hose about 2 ft. long. Sections from three hoses were chosen, two from new hoses and the other from a hose already in service which had developed rubber acid. Each section was bent in the shape of a U and into each, 25 ml. of test water, containing test bacteria, were introduced. The sections were then closed with clamps to reduce evaporation and incubated at room temperature. Each section was opened daily to admit oxygen and also shaken to keep the inner rubber surface wet. As control, a sterile section was taken from each hose. Into each of these, 25 ml. of sterile tap water was introduced, but no bacteria.

Table 2 shows the rate of change in *p*H values of the water contained in the various sections during 14 days of incubation.

TABLE 2.

CHANGES IN *p*H VALUES OF WATER KEPT IN RUBBER-LINED FIREHOSES

No.	Description	*p*H of water after incubation for			% of free sulphur in hose
		0 days	1 day	14 days	
1	New hose (sterile)	7·4	7·4	7·4	0·2
1*a*	,, ,, +sulphur-oxidizing bacteria	6·0	6·2	1·6	0·2
2	New hose (sterile)	7·4	7·4	7·4	<0·1
2*a*	,, ,, +sulphur-oxidizing bacteria	6·0	6·2	6·2	<0·1
3	Old hose (sterile)	7·4	7·4	7·4	0·1
3*a*	,, ,, +sulphur-oxidizing bacteria	6·0	6·4	2·7	0·1

There is an interesting deviation in the expected results tabulated in Table 2. One of the new hoses apparently did not respond as expected to the presence of sulphur-oxidizing bacteria. This was a hose in which the free sulphur present amounted to less than 0·1 per cent. Apart from this it was possible to confirm that the presence of sulphur-oxidizing bacteria is essential for the production of acid hose liquor.

In a further experiment with sections of the No. 2 new hose in which, in addition to sulphur-oxidizing bacteria, free sulphur was added to the water introduced into a sterile section, it was possible to show that the failure of acid production was due not to any inhibitory properties possessed by this hose, but to the presence of insufficient free sulphur. For in this additional experiment the *p*H value of the water contained in the section dropped to below 1·2 in the course of 14 days.

It is clear, therefore, that there are two factors governing acid production in hose: first the presence or absence of the relevant bacteria; and secondly, the presence of a sufficiency of free sulphur. This latter apparently should not fall below 0·1 per cent, calculated on the rubber lining. If the figures of Table 2 may be taken as substantially correct, acid production will be proportional to the percentage of sulphur present, other factors being favourable.

The presence or absence of sulphur-oxidizing bacteria will probably be governed largely by the type of water passing through hose when in use, and it was thought relevant, therefore, to examine fire-fighting water supplies for the presence of these organisms.

On inquiry it was found that much of the water available to the National Fire Service in the London district is taken from static supplies, these being replenished from the River Thames, or from local canals and ponds. Water taken direct from the mains is not used when other supplies are available.

An analysis of twenty-five samples of water from different sources of supply, including mains water, revealed that thirteen contained sulphur-oxidizing bacteria. Only two of the samples of mains water out of six examined contained these organisms. The percentage, therefore, of the crude waters used which contained these bacteria was no less than 58 per cent. The observation may perhaps give a clue to the frequency with which rubber acid is likely to be found in hose.

The presence of sulphur in rubber-lined hoses was found on inquiry to vary very considerably. Pre-war hose specifications, according to Phillips (*l.c.*), limited the free sulphur content in hose lining to 1 per cent in Great Britain and to 1·25 per cent in the United States. But these data are not a reliable guide, for recent analyses of twelve American samples showed the content to vary between 0·06 and 0·7 per cent. Similar variations are likely to occur in hose made in Britain and in Canada. From the data given in Table 2 it would appear that a free sulphur content of 0·1 per cent is sufficient to produce some acid, and that 0·2 per cent causes marked acid production. A permitted minimum of 1 per cent of free sulphur is therefore a gross excess, and can be expected to lead to acid production whenever the appropriate bacteria are present.

Conclusions. The conclusions to be drawn from the experiments which have been carried out would appear to be that:

The production of rubber acid in hose is due to the activity of sulphur-oxidizing bacteria of the *Thiobacterium thiooxidans* group.

Such acid will invariably be formed in rubber-lined hose which is stored with the linings wet, when the responsible bacteria are present and when the free sulphur content of the hoses exceeds 0·1 per cent.

If acid production is to be prevented, it is necessary to ensure, either that the rubber-lined hose is stored dry, or that its content of free sulphur is less than 0·1 per cent.

The alternative of preventing the introduction of the causal bacteria does not appear practicable, since the water used in fire-fighting is a frequent habitat of these bacteria.

In a series of additional experiments it was established that various organic sulphur compounds, commonly used in the vulcanization of rubber, failed to give rise to acid production, even in the presence of sulphur-oxidizing bacteria.

Thanks are due to the officers and men of the National Fire Service, and especially to Company Officer W. E. Gage, Hose Officer, No. 38 Fire Force,

who assisted us in obtaining the necessary experimental material and certain data required for this investigation. The work was carried out on behalf of the Director of Scientific Research, Ministry of Home Security, and is published with the approval of the Department of Scientific and Industrial Research and the Ministry of Home Security.

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OBITUARIES

Lord Dawson of Penn, P.C , G.C.V.O., K.C.B., K.C M.G.

The death on March 7 of Lord Dawson at the age of seventy-nine has removed from the ranks of the medical profession one of its most eminent members. Lord Dawson symbolized in his own person the many different services the profession can render to the community. He had been physician to several members of the Royal Family. He was the perfect consultant combining hospital appointments with private practice, always at the service of his patients at whatever inconvenience to himself. To the House of Lords, to which he was elevated in 1920, he brought fine qualities of statesmanship and oratory, and he did invaluable work there in presenting to the public the medical point of view. His scientific eminence was reflected in the many honours conferred on him by universities and medical societies all over the world.

Lord Dawson was a prolific writer and lecturer on a wide variety of medical subjects. He took a prominent part in the organization of the medical services and the famous Dawson Report, produced under his chairmanship by the Consultative Council on Medical and Allied Services appointed at the time of the creation of the Ministry of Health in 1919, is a milestone in the history of medical services. If the Government had acted upon the advice offered in that Report we might have been saved many of the problems the profession is facing to-day. Lord Dawson's wisdom in guiding the domestic affairs of his profession was recognized by his election to the presidency of the Royal College of Physicians during 1931–38 and to the presidency of the British Medical Association in its centenary year in 1932. He was recalled to the presidency of the British Medical Association in 1943 to lead the profession in the present critical stage of the development of the medical services of Great Britain.

To all his work Lord Dawson brought a rare vigour and wisdom and sympathy. He saw the practice of medicine as a means of making people healthy and happy. His charm and courtesy endeared him to all with whom he came in contact, both professionally and socially, and his pervasive influence will be sorely missed by the medical profession and the scientific world.

We regret to announce the following deaths:

Sir Charles Bell, K C.I.E., C.M.G., an authority on Tibet, aged seventy-four.

Sir George Humphreys, K.B.E., formerly chief engineer to the London County Council, president in 1930 of the Institution of Civil Engineers, on March 9, aged eighty-one.

Sir Hanns Vischer, C.M.G., C.B.E., honorary secretary-general of the International Institute of African Languages, on February 19, aged sixty-eight.

Prof. H. H. Whetzel, professor of plant pathology in Cornell University, on November 30, aged sixty-seven.

NEWS and VIEWS

Helium for the Royal Society Mond Laboratory

The National Research Council of Canada has recently made a gift of 2,000 cubic feet of helium gas to the Royal Society Mond Laboratory at Cambridge. This amount of gas will enable the Laboratory to recommence research on very low temperature problems and on a scale which will allow the full resources of the Laboratory to be employed. In the whole field of physics, the temperature region close to the absolute zero remains one of the most fruitful for investigation. The low-temperature problems which received most attention before the War were those of superconductivity, magnetic cooling and the properties of liquid helium itself. These are, however, only the more prominent aspects of a wider field of investigation. Many mechanical, electrical, magnetic and optical phenomena, which are either partially or completely obscured by thermal agitation at room temperature, stand out clearly and undisturbed in the quiet region from 5° absolute down to 0·01° absolute which is attainable with liquid helium.

Grants for Scientific Investigations and Publication

The Royal Society has now been informed that the Treasury has made provision in the estimates for the fiscal year 1945–46 for the following grants which are administered by the Royal Society: for scientific investigations, £14,000; for scientific publication, £7,000; for scientific congresses, £1,600. In view of the greater amounts to be available if these estimates are accepted by Parliament, and of present changing conditions, the Royal Society has decided that more frequent allocation is desirable. The last dates, therefore, in 1945, for receiving applications for grants from the Parliamentary Grant-in-Aid for Scientific Investigations will be March 31, July 31 and November 30, and the last dates for receiving applications for grants from the Parliamentary Grant-in-Aid for Scientific Publication will be June 15 and November 15.

Cosmic Ray Studies in the Pamirs

A group of scientific workers from the Lebedev Institute of Physics, Moscow, has left for the Pamirs to study the composition of cosmic rays at high altitudes. The expedition is under the direction of Prof. Skobeltsyn, of the U.S.S.R. Academy of Sciences, and will continue studies that have been carried on for several years on Mt. Elbrus by workers from the Atomic Nucleus Laboratory. The main object of the expedition is to determine the part played by heavy particles and secondary mesons first discovered in the study of cosmic radiations in 1937. Cosmic

radiations have two sharply defined components—a hard component consisting of mesons possessing great energy and a soft component including positrons and electrons. It is known that the soft component, at any rate at sea-level, is genetically connected with the hard component, being apparently generated by the latter. At great altitudes the presence of an unbalanced component has been discovered, namely, radiation that is not directly connected with the hard component. The study of cosmic radiations at great heights is therefore of great importance for the understanding of cosmic radiations as a whole. The question of secondary mesotrons and other strongly ionized agents causing ionization impulses is of great interest. The problem of the generation of secondary mesotrons has gained in significance in recent times.

In order to study mesons, the expedition will make use of an improved form of 'proportional telescope'. In studying cosmic rays at great heights, they will take into consideration 'atmospheric rain', a phenomenon of cosmic rays discovered by a French physicist, P. Auget. Skobeltsyn has studied all the available experimental data, especially those obtained in the Elbrus Laboratory, and has come to the conclusion that a considerable proportion of the impulses are due to processes other than 'Auget's rain'. The expedition will try to prove this by the method of coincidences. An important part of the work of the expedition will be the study of the transition effects of the soft component, that is, the processes which occur when rapid protons and electrons leave matter with one atomic weight and enter the orbit of substances with a different atomic weight. The cycle of studies devoted to these particular effects, which was begun before the War, will be continued, employing greatly improved methods which the Atomic Nucleus Laboratory has recently evolved.

Educational Needs in Liberated Countries

THE sixteenth meeting of the Conference of Allied Ministers of Education was held on March 7 under the chairmanship of the Right Hon. R. A. Butler. The Belgian Minister of Education, M. Buisseret, made a special visit to London in order to attend. Mr. Butler stated that considerable progress has been made towards the establishment of a United Nations organization for educational and cultural reconstruction, and it was announced that it would be possible, after the San Francisco meetings, to make proposals for the final constitution of the new organization. M. Buisseret presented a statement to the Conference stressing the difficult position which has resulted from the Nazis' forceful educational propaganda among teachers and in schools, especially in the small, mainly German-speaking areas of Belgium, which in the course of the occupation had been annexed to Germany. It was pointed out that similar problems might arise in other countries which had suffered occupation. The Conference was informed that a new Commission has been formed "to collect information from liberated countries and elsewhere about the educational needs of, and the work being done for, children and young people requiring special educational treatment ; to make the necessary contacts with other bodies engaged on similar activities and to make recommendations to the Conference as to how the information can best be made available and assistance given if desired to the Allied Governments". Mr. J. A. Lauwerys has been appointed to direct the inquiry, and will have his headquarters at 3–5 Salisbury Square, London, E.C.4. The Conference adopted the following resolution, and decided that it should be communicated to the Allied Governments through their delegations: "The Conference of Allied Ministers of Education, having considered reports from liberated territory, records their unanimous view that the need for the supply of raw material for educational purposes, and in particular for school books, is of paramount importance. Unless such supplies are made available the Conference believes that the resumption of educational activities will be greatly delayed and additional hardship for the children, students and parents in liberated territories will result."

Restoration of Libraries

UNDER the auspices of the Conference of Allied Ministers of Education, a committee has been set up to administer the organization and premises known as the Inter-Allied Book Centre, 3–5 Salisbury Square, London, E.C.4, where books can be received and systematically arranged for ultimate allocation to libraries in Great Britain and abroad which have been damaged or destroyed during the War. Already more than a million books, ranging over the whole field of knowledge, have been set aside, by action of the Government, from collections made primarily for salvage purposes. The collection includes books of every kind ; but the proportion of modern technical, scientific, commercial and legal works is low. Many libraries will urgently need sets of the more important periodicals, particularly the back numbers of journals and transactions. Those unable to give books or periodicals can support the general scheme by money contributions, which will be used entirely for the purchase of books and periodicals ; but so many books have been destroyed, or are in short supply, that the need is for books rather than money. It is generally thought that the committee of allocation should have a free hand to decide the ultimate destination of all books received ; but if a donor urgently desires to give to a particular country, or even a particular library, he is asked to communicate with the director of the Book Centre. Bodies which are already collecting books for specific countries or institutions are asked to supply the director with lists of books and periodicals which they propose to distribute, so that they can be taken into account by the Centre in making its own distribution. Donors are asked to send to the director of the Centre, Mr. B. M. Headicar, lists of the books available ; carriage will be refunded, if desired, on all books presented.

Royal Institute of Chemistry

AT the sixty-seventh annual general meeting of the Royal Institute of Chemistry held on March 12, at the Institute, 30 Russell Square, W.C.1, Prof. Alexander Findlay, the president, in moving the adoption of the annual report, emphasized the growing opportunities for men of science to bring about a better balance between science and politics and between knowledge and power. The tasks of Government and the formation of a national and international policy which will secure the fullest and most complete development and expression of human nature, when beauty and goodness merge and blend together with truth, depend in part on values other than the scientific, and involve problems which cannot be solved merely by the application of the laws of natural science. But in securing the material well-being of the people and in advancing industrial pros-

perity, science is all-important and, in Prof Findlay's opinion, representatives of scientific institutions on the Parliamentary and Scientific Committee are playing a particularly important part in keeping the Government informed regarding the discoveries and applications of science to human and industrial well-being, and in providing a scientific method of approach to the problems of national administration, a method infused with the spirit of truth rather than of prejudice or party partisanship.

Prof. Findlay stated that the roll of membership of the Institute has increased by 523 to 9,227, and the register of students by 205 to 1,225 during the past year. He also referred to the greater collaboration among the various organizations of chemists and the better co-ordination of their activities, in which representatives of the Institute have continued to play their part. He congratulated the Chemical Council on having gained from industrial firms and private subscribers greatly increased financial support for chemical publications. During the sixty years since the Institute was incorporated by royal charter, its membership has increased twenty-fold and there has also taken place remarkable expansion of the activities of chemists. The time has now come to reformulate its aims and interests and to adapt its organization so as the more effectively to achieve its aims and fulfil its responsibilities; proposals for modifying the charter and by-laws are to be laid before the members in due course. Reference was made to the retirement of Mr. Richard B. Pilcher, who had been secretary for fifty years and for forty-five years registrar and secretary, and the appointment of Dr. H. J. T. Ellingham as secretary and Mr. R L. Collett as registrar. Prof. Findlay was re-elected president.

Pedigree of Fossil Man

PROF. RUGGLES GATES has produced a very concise and interesting article on the pedigree of fossil man (*Amer. J. Phys. Anthrop.*, 2, No. 3; Sept. 1944) He reviews the opinions of others, discusses modern tendencies and viewpoints, and summarizes his own conclusions. So long as the data supplied relative to the finds of prehistoric man are reliable, the conclusions arrived at by the physical anthropologists must, of course, be treated with great respect. But unfortunately, really well-authenticated and documented discoveries of prehistoric skeletons are more than rare. For example, Prof. Ruggles Gates says: "The evidence of the Committee which investigated the Swanscombe parietal and occipital shows that stratigraphically it is one of the best authenticated of all human remains, and geologically the evidence of the age of the gravels in which they were found is very complete". In the sense that the exact horizon whence came the bones is known, this is certainly true; but it is not enough, for in those Swanscombe gravels both Acheulean and Clactonian industries occur mingled. To say the least, it is still possible that the prehistoric folk who made the *coup-de-poing* industries were entirely distinct from those flake-tool makers who produced the Clacton, Levallois and other flake industries. A study of distribution maps strongly suggests that such a distinction should be made. Now the early flake-tool folk were the ancestors of the Mousterians, that is, of Neanderthal man, whereas the *coup-de-poing* makers appear to have quite another story—perhaps an African one—and it is thus still impossible to be certain to which of these two cultural facies the Swanscombe bones belonged. It is not until problems like this—purely matters for the prehistorian to settle—are resolved that the physical anthropologist can satisfactorily do his job. Bearing in mind this warning note, Prof. Ruggles Gates's paper makes interesting and informative reading. He is trying to give answers to just those questions many would like to have elucidated; among other interesting conclusions he places Neanderthal man, in accordance with Weidenreich, in the chain of development from *Pithecanthropus* and *Sinanthropus* to "the modern type of man". Not all anthropologists would agree.

Length of Small Intestine

THE capacity of the human body to withstand remarkable injury or loss of what may seem to be essential organs is continually astonishing those who have to deal with injuries sustained in war and peace or with the results of surgical operations. C. C. Holman (*Lancet*, 597, Nov. 4, 1944) has reported the instance of a woman who, having survived the removal of her uterus and of the breast for cancer ten and six years earlier respectively, had to sustain, at the age of fifty-six, the removal of twenty feet of her small intestine: a lateral anastomosis was performed between the jejunum and the transverse colon. The patient recovered and three months later had gained 2 lb. in weight. A year after the operation she weighed rather more than before her operation and was doing the parish work as a clergyman's wife.

In an Annotation on this case, the *Lancet* says that people have survived, for several years at least, with only 3 ft. of combined duodenum and jejunum and no ileum. It has been calculated (H. E. Haymond, *Surg. Gynec. Obstet.*, **61**, 693; 1935) that removal of up to one third of the total length of the small intestine could be followed by return to normal function; but that poor results might follow removal of more than half of it, or eleven feet in average people. It is pointed out, however, that the length of bowel removed gives no true indication of the length which remains, because the total length of small intestine varies between 10 ft. and 28 ft. 4 in., according to J. Bryant (*Amer. J. Med. Sci.*, **167**, 499; 1924), who measured the small intestine at autopsy in 160 adults. When the gut is alive, it is a great deal shorter, possibly half the length measured at autopsy or less. Another case, reported by J. A. Cosh in the same issue of the *Lancet* (p. 596), was less fortunate. This was a man aged sixty-seven, from whom all the small intestine was removed except the duodenum and about 3 ft. of the jejunum. For about eight months he had fairly good health, but then became ill and died twelve months after the operation.

Announcements

PROF. BENGT EDLÉN, of Lund Observatory, Sweden, has been awarded the Gold Medal of the Royal Astronomical Society for the year 1945 for his identification of the origin of the principal lines in the coronal spectrum.

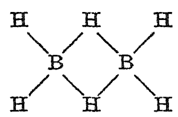
THE Council of the University of Sheffield has appointed Dr. Harry Moore to the chair of glass technology in succession to Prof. W. E. S. Turner, who is to retire at Christmas 1945; Dr. H. A. Krebs to the newly created chair of biochemistry; and Mr. A. E. Bender to be research biochemist in the Department of Pathology, to work in association with the Sheffield Radium Centre.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

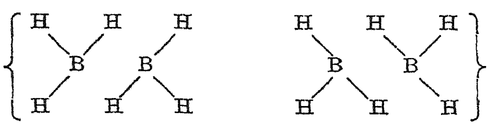
Structure of Boron Hydrides

As recently shown[1], the interpretation of polyatomic structures does not require the hypothesis of resonance among several idealized valence-bond structures, a speculative application of the quantum-mechanical conception of resonance, which is in disagreement with numerous facts. They are accounted for by the principles of the classical (atomic and electronic) structural theories. The boron hydrides have been represented as resonance hybrids involving structures with one-electron linkages. Longuet-Higgins and Bell[2], in a most interesting and important discussion, have given convincing evidence that the introduction of the unique and theoretically unlikely one-electron linkage between two unequal atoms is unnecessary, and that the boron hydrides should be represented by the bridge formulæ of type



containing hydrogen bonds[3].

Since hydrogen bonds are generally formed between atoms with unshared electrons and hydrogen atoms belonging to strongly polar linkages, whereas no unshared electrons are available at the B atom and the B—H linkage may be only slightly polar, Longuet-Higgins and Bell prefer to distinguish the linkages in the boron hydrides from other hydrogen bonds as resonance links. This implies a stabilization due to resonance involving no electron linkages. It is assumed that electrons belong to the orbitals of more than two atoms, that is, are non-localized.



However, two factors should be essential for the formation of the electrostatic hydrogen bond: (1) presence of opposite charges at the two atoms; (2) the possibility of a sufficiently close approach of the atoms. Decreasing size of the atoms and absence of other atomic orbitals sterically inhibiting the approach of the second atom will facilitate the formation of a hydrogen bond. Such favourable conditions exist particularly in the case of small and unshielded atoms such as H, B, F, O, etc.; the presence of unshared electrons is incidental. The charges at the B and H atoms in boron hydrides may be small; but this could easily be compensated by the presence of two linkages and the rather short B . . . H distances, which should not be longer than 1·6 A.

It is not justifiable to assume that the H atom in BH_3 is unlikely to form a hydrogen bond of an essentially electrostatic nature with the B atom of another molecule, because this ability decreases rapidly in the series HF, H_2O, H_3N, H_4C. The charge at the H atom being positive will decrease in the former three molecules to become negligible, although possibly already negative in CH_4 [4]. Certainly in BH_3 it should be negative* and again greater. Moreover, in contrast to the completely shielded C atom in CH_4 the B atom, like the F, O, and N atoms, will allow the approach of another H atom.

The formation of stable ring structures rather than of long-chain structures by hydrogen bonds will depend on steric influences, including the ability of the participating atoms to form sufficiently strong linkages at the angles required. Steric conditions being satisfied, ring structures of smallest polymerization degree will always be more stable because of the increased stability due to an additional hydrogen bond and an increased polarization of the linkages involved. Thus, carboxylic acids possess a dimer ring structure, *ortho*-nitrophenol and numerous similar substances form intramolecular rather than intermolecular hydrogen bonds.

The formation of an electrostatic linkage will, of course, not only depend on the size of the atoms essentially determining the interatomic distance, but also on the degree of their charges, which will increase in the series $(+)B—H(-) < (+)Al—H(-) < (+)Ga—H(-)$ and compensate for the lengthening of the interatomic distance.

The interpretation of the unexpectedly complicated infra-red spectrum of diborane has offered considerable difficulty[5]. An analysis based on the suggested structure containing different covalent B—H and electrostatic B . . . H linkages should be of interest. However, a decision between these structures is only possible by a comparison of analyses based on both the 'symmetrical' and the 'unsymmetrical' bridge structure.

The stability of boron hydrides does not require the introduction of a new type of resonance involving no electron linkages.

A. BURAWOY.

College of Technology,
Manchester.
Dec. 21.

* During a discussion following a lecture by Mr. R. P. Bell on November 30, Prof. J. Kenner independently directed attention to this point and emphasized its importance in relation to this problem.

[1] Burawoy, *Trans Far. Soc*, 40, 537 (1944); *Chem. and Ind.*, 434 (1944); cf also Burawoy, *Trans Far. Soc.*, 39, 79 (1943) *Chem. and Ind*, 855 (1940). Samuel, *J. Chem. Phys.*, 12, 167, 180 380 (1944).

[2] Longuet-Higgins and Bell, *J Chem Soc.*, 250 (1943).

[3] For original literature, see ref 2

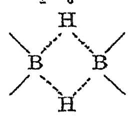
[4] Timm and Mecke, *Z Phys*, 98, 363 (1935). Fuchs and Wolf, "Dielektrische Polarization", Hand- und Jahrbuch der Chem Phys, 356 (Leipzig, 1935) Tieschmann, *Z. phys Chem*, 32B, 22 (1936) Cf, however, Smyth, *J Phys Chem.*, 41, 215 (1937).

[5] Stitt, *J. Chem. Phys*, 9, 780 (1941)

THE chief contention put forward in our earlier paper was that in diborane and similar molecules there were pairs of hydrogen atoms which occupied a special position in linking together different parts of the molecule. We agree with Dr. Burawoy that the formulation of these links as resonance hybrids represents only one way of describing this state of affairs: for example, a molecular orbital treatment of the system would not involve the use of the resonance concept. On the other hand, we doubt whether this linkage can be regarded as an electrostatic 'hydrogen bond' of the type met with in HF, H_2O and NH_3. The tendency to this type of dipole association decreases rapidly along the series FH, —OH, > NH, C≥H, and it would be remarkable if it appeared again to a high degree in > BH. It is, of course, conceivable that the BH link has a considerable dipole with the negative end on the hydro-

gen atom, but it is not likely that this would lead to the formation of a stable dimer showing no tendency to further polymerization. A much more likely result would be the formation of an indefinite series of polymers, as is the case with H_2O, HF and NH_3 It is improbable that the small size of the boron atom is a determining factor, since the hydrogen compounds of aluminium and gallium dimerize as well as those of boron.

If B_2H_6 did contain electrostatic hydrogen bonds, the two central hydrogen atoms would not be equidistant from the two boron atoms. As Dr. Burawoy suggests, information on this point might be obtained from the vibrational spectrum of diborane, though the differences in symmetry involved are not such as to produce markedly different selection rules for the symmetrical and unsymmetrical models. However, we have recently made detailed calculations of the normal vibrations of a B_2H_6 molecule containing a symmetrical bridge



, and have obtained excellent quantitative agreement with the observed infra-red and Raman spectra[1]. This agreement makes it unlikely that the central hydrogen atoms are unsymmetrically placed.

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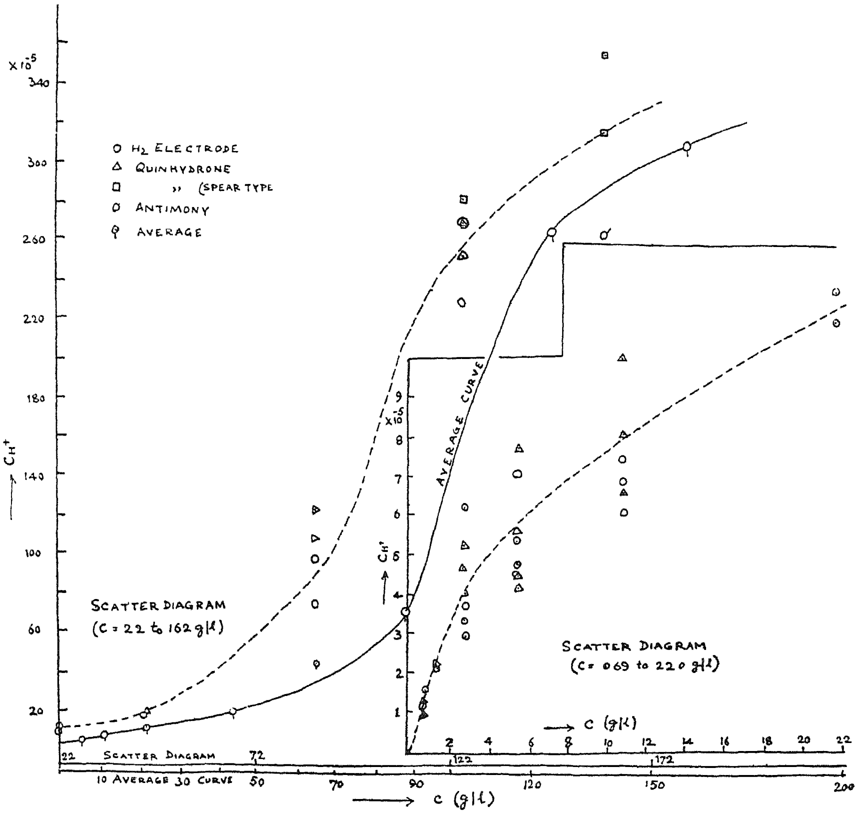
[1] Details will appear shortly in *Proc Roy Soc.*, A

Effect of Concentration on the Free and Titratable Acids of Hydrogen Bentonites Sols

Hydrosols of hydrogen clays and hydrogen bentonites show a marked acid character and give potentiometric and conductometric titration curves with bases having definite inflexion points and breaks[1,2,3]. A linear relation between the H^+-ion concentration C_{H^+}, and the concentration of the colloid, C, was observed by Wiegner and Pallmann[4] in the case of dilute sols having concentrations up to about 0·3 per cent. At higher concentrations the slope, dC_{H^+}/dC, progressively decreased. Some interesting effects of the concentration of the colloid on the H^+-ion concentration of the sol as well as the amount of the acid calculated at the inflexion point of the potentiometric titration curve with sodium hydroxide have been observed in the case of a hydrogen bentonite, Kashmir-*B*, isolated from a deposit of bentonite in Kashmir. X-ray analysis showed that Kashmir-*B* did not probably contain any mineral other than montmorillonite[5].



Hydrogen, quinhydrone and antimony electrodes were used for measuring the *p*H. A 'spear type' quinhydrone electrode prepared as described by Sanders[6] was also used in the case of very concentrated sols and pastes.

Several determinations of the *p*H were made at each concentration. These are shown on the accompanying scatter diagrams drawn separately for two ranges of concentrations, 0·069–2 2 per cent and 2·2–16·2 per cent. The full curve shows the average C_{H^+} at the various concentrations.

C_{H^+} increases almost linearly with C until the latter attains a value of about 0·2 per cent. Beyond this point, and up to a concentration of about 2 per cent, the slope, dC_{H^+}/dC ($= \alpha$), gradually diminishes. A sudden decrease in the cataphoretic velocity and a rapid fall of the equivalent conductivity were previously observed[7] at a concentration of about 0·2 per cent of the same hydrogen bentonite sol.

The slope, α, increases at concentrations higher than 2 per cent, and a steep rise and an inflexion in the $C_{H^+} - C$ curve is observed at a concentration of about 10 per cent. Beyond this concentration the slope again decreases.

The progressive decrease in α at moderate concentrations possibly indicates a secondary adsorption of increasing numbers of mobile H^+ ions of the double layer[8]. The increase in the slope and the inflexion observed at higher concentrations are to be

attributed to a re-liberation or 'mobilization' of some of the secondarily adsorbed H^+ ions by strong fields of force which operate as the individual double layers overlap. The formation of some sort of a structure in the system is indicated. The viscosity of the sol has been found to increase rapidly with the concentration, and the system becomes thixotropic (the sol sets in about three hours) at approximately the same concentration at which the sharp rise in the H^+ ion concentration occurs.

The potentiometric titration curve of the sol with sodium hydroxide has a weak monobasic acid character and shows a marked inflexion at pH 8·5. The amount of the acid (T) neutralized at the inflexion point increases from 81·0 to 103·0 m.e. per 100 gm. of the oven-dried hydrogen bentonite as the concentration increases from 0·25 to 8·8 per cent. T increases with C at a much smaller rate than C_{H^+}, especially in the range of concentrations where the inflexion in the $C_{H^+} - C$ curve is observed. The increase in T with C is due to factors other than those responsible for the variations in the base-exchange capacity of hydrogen clays which have been observed when the sols are titrated with different bases, and in the presence and absence of salts[9,10]. Assuming that aggregation or structure formation in the concentrated sols causes a decrease in the available surface, a decrease instead of an increase in T would be expected at the higher concentrations if the interaction with the base were confined to the outer surface of the particles.

This work has been carried out with the aid of a grant from the Imperial Council of Agricultural Research, India.

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[1] Mitra, *Ind J. Agric. Sci*, 6, 555 (1936).
[2] Mukherjee Mitra and Mukherjee, *Trans. Nat. Inst. Sci. Ind.*, 1, No 10, 227 (1937).
[3] Mukherjee and Mitra, *Ind J. Agric. Sci*, 12, 433 (1942).
[4] Wiegner and Pallmann, *Ver. Zwei. Komm. Alkali-subcomm. Internat. Bod Ges*, B, 92 (1929).
[5] Unpublished work of S N. Bagchi.
[6] Sanders, *Ind. Eng. Chem.*, Anal. Ed., 10, 274 (1938).
[7] Mukherjee and Sen Gupta, *Nature*, 145, 971 (1940).
[8] Mukherjee, *Kolloid Z.*, 62, 257 (1933).
[9] Mitra, Mukherjee, S, and Bagchi, *Ind. J. Agric. Sci.*, 10, 303 (1940).
[10] Mukherjee, Mitra, Chatterjee and Mukherjee, S., *Ind. J. Agric. Sci.*, 12, 86 (1942).

'Figure of Merit' of X-Ray Tubes

AT the Leeds meeting of the X-Ray Analysis Group of the Institute of Physics[1] I gave certain figures for the comparative speeds of photographs using a Philips tube, a Shearer gas-tube and the 5 kW. filament tube at the Davy Faraday Laboratory.

In justice to the commercial tube makers, I ought to make it clear, as I hoped I had made it clear at the meeting, that the Philips tube I had used for purposes of comparison (the only one available to me at the time) was already eleven years old and had, in fact, since 'died'. The Shearer tube was just as old, but demountable tubes never die, they only fade away, when it becomes desirable to replace them by a more modern design. The tests I carried out were also made under particular conditions, that is, using a ½ mm. diameter cylindrical collimator and a rotating single crystal. I have since had the opportunity of repeating these and other tests using a more modern (just pre-war) Philips tube and other commercial tubes; and I find that, in the same exposure time, the Shearer tube still gives the most intense single-crystal photograph using copper K radiation, but the difference is smaller.

The gas-tube focus is (as used in projection, and under our running conditions) about 2 mm. × 1 mm., and a ½ mm. cylindrical slit therefore wastes at least seven-eighths of the tube output in the required direction. If a still finer slit were to be used for crystals having large unit cells and therefore requiring high resolution of reflexions on the photographs, the wastage of output would be even greater; but for powder spectroscopy, for which a 2 mm. × ½ mm. straight slit could be used, it would be much less.

I strongly agree with Sir Lawrence Bragg that manufacturers should give some 'figure of merit', which should indicate both focal spot size and comparative output of the various tubes now made. The principal advantages of the gas-tube are the purity of its radiation even after long running, the low input (about 400 watts) and the very low initial cost of the whole outfit, when an induction coil and electrolytic interrupter are used. These factors ought also, of course, to be considered in connexion with any standards of comparison that might be adopted. The cost is particularly important, because the price of apparatus is, unfortunately, a serious and sometimes crippling consideration with research workers in general.

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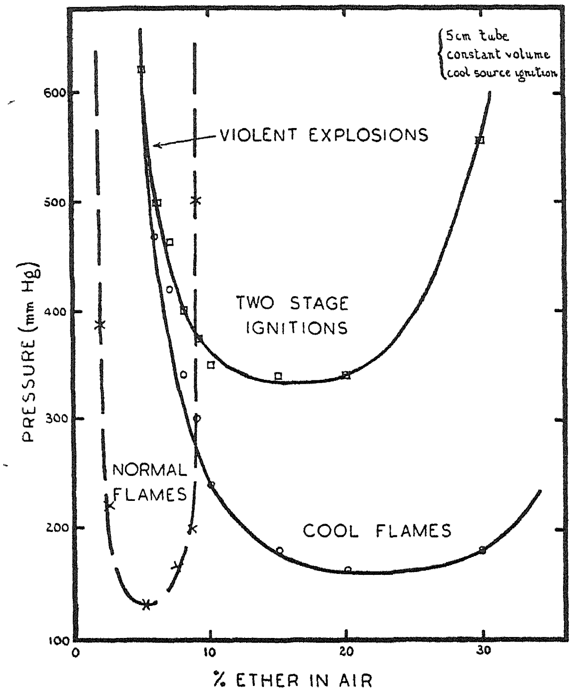
[1] "X-Ray Equipment for Crystallography", *Nature*, 155, 244 (1945).

The Cool-Flame and Two-Stage Ignition Systems in Ether – Air Mixtures at Room Temperature

THE normal and cool-flame systems in diethyl ether – air, etc., mixtures have been defined by means of diagrams showing the influence of pressure on their respective ranges of inflammability[1]. Whereas the normal flame range centres upon approximately the theoretical mixture or that capable of developing the highest flame temperature and consequent flame speed, the cool-flame range appears to centre upon the mixture giving rise to the fastest reaction in slow combustion. High-tension sparks are employed for igniting the normal flames, but a suitably heated element must be used for the cool flames. If the experimental pressures in the cool-flame range be increased, pressure-composition limits may also be defined for the initiation of a second-stage 'blue' flame in the cool-flame products; this arises from the autogenous decomposition of peroxidic material formed in these products. This two-stage phenomenon is identical with that occurring in media *spontaneously* ignited at suitable temperatures and pressures[2], the essential difference being that with artificial ignition in cold media, the limiting pressures are much higher.



Hitherto it has not been possible with cold media to identify the cool-flame range within the normal flame range, for attempted ignition of cool flames by the means stated has invariably given rise to normal flames. An advance in this field has recently been made in that it is now possible completely to establish the cool-flame system (see graph); this was achieved in the first instance by allowing a cool flame initiated in a combustible-rich mixture located in one section of a 1·5 cm. tube to pass into a mixture of composition within the normal flame range located in another section, connexion being effected by means of a uniform-bore tap. Similar observations have also been made with higher hydrocarbons and other suitable combustibles; and later the procedure became simplified when it was found possible successfully to employ a specially designed igniting source at rigidly controlled temperature. The importance of these observations may be appreciated by the statement that under suitable pressure conditions it is possible for a cool flame to travel quiescently through even a *theoretical* combustible air – oxygen mixture which, if subjected to a spark or other usual igniting source, would give rise to an explosion shattering the containing vessel. At higher pressures (Fig. 1) the two-stage ignition mechanism occurs, giving rise in such a mixture to an explosion of great violence and of the type enhanced by shock waves. Indeed, there is strong evidence that under the conditions arising in internal combustion engines this two-stage ignition mechanism is, in fact, that responsible for 'knock'.

These observations throw light on the kinetics of the processes concerned; they may also be of significance when considering possible sources of ignition of inflammable vapour – air media in industries where solvents are employed, or possibly in operating theatres in hospitals. For it is possible for a cool flame initiated by a low-temperature source in a rich mixture (for example, ether vapour near a floor) to pass unobserved for some distance until, on passing into a mixture of higher oxygen content (for example, ether vapour more remote from a floor), an explosion of violence might occur.

The investigations referred to form part of a larger programme assisted by the Department of Scientific and Industrial Research.

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D. T. A. Townend.
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University, Leeds, 2.
Jan. 23.

[1] White, *J Chem. Soc*, 1462 (1919), 498 (1927). Townend and Chamberlain, *Proc. Roy Soc*, A, **158**, 415 (1936). Hsieh and Townend, *J. Chem Soc.*, 337 and 341 (1939) Maccormac and Townend, *J Chem Soc.*, 143 and 151 (1940)
[2] For example, Townend, *Chem. Rev*, **21**, 259 (1937).

Particle Shape

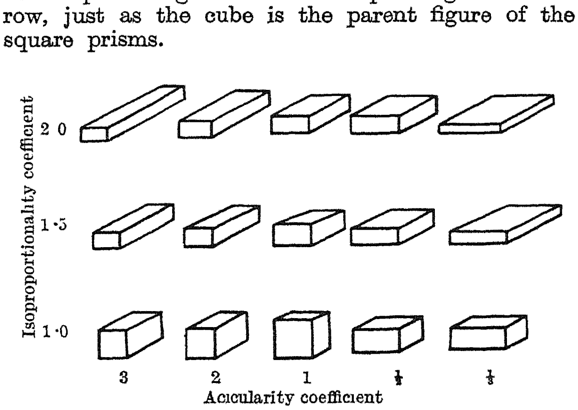
In the chemical literature it is customary for crystalline substances to be characterized as forming needles or plates. It is interesting to note that this concept of acicularity can be given a precise quantitative meaning and applied to any regular solid figure of which the three principal dimensions are known, and may be extended to cover the general form of irregular figures. In the present instance, rectangular solids are considered for the sake of simplicity, and the three dimensions denoted as a, b, c, where $a \geqslant b \geqslant c$.

Psychological tests have shown that a figure is instinctively considered to be acicular if $a:b$ is greater than $b:c$, and tabular if $a:b$ is less than $b:c$. If $a:b$ equals $b:c$, no decision can be obtained as to whether the body is to be considered acicular or tabular. This criterion, related as it is to ordinary experience, is therefore considered to be the most satisfactory to adopt, and we define a quantity called the 'acicularity coefficient' as

$$\text{acicularity coefficient} = a:b \div b:c.$$

Bodies thus have an acicularity coefficient greater than unity if needle-shaped, and less than unity if tabular.

In the accompanying diagram the acicularity coefficient is constant in any vertical column. Another parameter is therefore required in order to specify uniquely any given shape. This is provided by $a:b$ or $b:c$, whichever is the smaller. For this parameter we propose the name of 'isoproportionality coefficient', as it specifies the figure in the central column of the diagram which may be considered to be the parent figure of the corresponding horizontal row, just as the cube is the parent figure of the square prisms.



The correct method of applying these concepts statistically to a collection of particles is indicated as follows. If the particles have no inherent tendency to a needle- or plate-like form, it follows that those with an acicularity coefficient of n and $1/n$ will occur with the same frequency, and hence, for any one value of the isoproportionality coefficient, the sum of the values of $a:b$, and the sum of the values of $b:c$ will be equal; that is

$$\overline{a:b} \div \overline{b:c} = 1.$$

Any inherent tendency to needle- or plate-like form will modify this value accordingly, and we therefore define a quantity, the acicularity factor, as

$$\text{acicularity factor} = \overline{a:b} \div \overline{b:c},$$

which is equal to the acicularity coefficient of a mean particle averaged in the special way involved in this definition. This derivation is applicable severally to groups of particles having every possible value of the isoproportionality coefficient, and therefore is applicable to any group of particles whatever, providing it be sufficiently large.

For statistical use, the isoproportionality coefficient will similarly give place to the isoproportionality factor, defined as

$$\text{isoproportionality factor} = \overline{x:y},$$

where $x:y$ is the smaller of the two ratios $a:b$, $b:c$, for each individual particle.

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Boron and Strontium in New Zealand Coal Ashes

ATTENTION has been directed by V. M. Goldschmidt[1] to the occurrence of minor elements in coal ashes. During the complete analysis of ash of Waikato coal examined in connexion with clinkering troubles, Mr. F. T. Seelye, chief chemist at the Dominion Laboratory, New Zealand, noted a high boron content. The Coal Survey Division then undertook an examination to determine the distribution of boron in New Zealand coal ashes. Boron was present in highest amount in Waikato coals, but was also present in smaller percentages in all New Zealand coals.

The accompanying table sets out the maximum and average percentages of boron in each coalfield. The factor of enrichment of boron in coal ashes has been worked out as in Goldschmidt's paper, by comparing the percentage of boron in coal ash with the percentage of boron in the earth's crust taken as 0·0003.

Coalfield	Class of coal	Maximum % boron	Average % boron	Factors of enrichment Maximum	Factors of enrichment Average
North Auckland	Sub-bituminous	0·21	0·21	700	700
Waikato	,,	1·51	1·09	5,000	3,[illegible]00
Taranaki	,,	0·73	0·58	2,400	1,900
Westport	Bituminous	0·29	0·29	1,000	1,000
Reefton	Sub-bituminous	0·86	0·86	3,000	3,000
Greymouth	Bituminous	0·15	0·07	500	250
Otago	Lignite	0·14	0·11	500	400
Kaitangata	Sub-bituminous	0·44	0·39	1,500	1,300
Southland	,,	0·24	0·18	800	600
Chatham Islands	Peat	0·10	0·10	300	300
Goldschmidt's figure for coal ashes rich in boron		0·30	0·06	1,000	200

Another element occurring in unusual amounts is strontium. Strontium has been determined by a spectrographic method similar to that described by Wilson and Fieldes[2], but modified by them to permit the determination of strontium directly on the ash, without separation of lime and strontia (unpublished method).

Strontium was found to be much higher than is usual in rocks, amounting to 0·3 per cent strontium oxide in several Waikato coal ashes. In ash from Mangapehi, an area south of the Waikato coalfield, the strontium content was found to be far above the amount usually determined spectrographically. A chemical determination revealed 1·3 per cent strontium oxide. The percentage was then confirmed by modifying the spectrographic method.

Further information is necessary before any conclusion as to the reason for these high concentrations can be put forward. It is significant that boron and strontium are relatively high in sea-water, and the high content of both may be connected in some way with contact of the coal measures with the sea. It must also be noted that the coals high in these constituents occur in hot spring or volcanic areas.

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[1] Goldschmidt, V. M., *J Chem. Soc.*, 655 (1937).
[2] Wilson, S. H, and Fieldes, M, *N.Z J. Sci. and Tech.*, 24, 98 (1942).

Red Shift in the Anagalactic Nebulæ

A PHOTON $h\nu$ emitted by a distant nebula toward our galaxy possesses a mass

$$\mu = \frac{h\nu}{c^2} \quad . \quad . \quad . \quad . \quad (1)$$

and the equation for its energy is

$$h\nu = \mu c^2. \quad . \quad . \quad . \quad . \quad (2)$$

The mass μ of the photon is acted upon by the gravitational field of our galaxy, whatever this field may be: Newtonian, LeSagian[1], or the relativistic curvature of space caused by the mass of the galaxy.

The law of gravitation requires that any mass in the field of our galaxy must be accelerated toward it. Therefore, using the inverse square law for falling bodies, the energy of the photon from the nebula we observe should be

$$h\nu = \mu\left[\sqrt{c^2 + k\left(1 - \frac{R}{A}\right)}\,\right]^2 = \mu\left[c^2 + k\left(1 - \frac{R}{A}\right)\right], \quad . \quad (3)$$

where $k = \dfrac{2GM}{R}$, R is radius of our galaxy (assuming

it to be spherical as a first approximation), A is the distance from the galaxy to the nebula, M is mass of our galaxy, and G is the gravitational constant. However, according to the principle of relativity, no mass can acquire a velocity greater than c, the velocity of light *in vacuo*. Consequently, in order to preserve the law of gravitation, together with the conservation of energy involved, and to agree with the principle of relativity the following equation must be satisfied:

$$h\nu - \mu k\left(1-\frac{R}{A}\right) = \mu c^2, \quad . \quad . \quad . \quad (4)$$

or, substituting μ by its value from (1), we have

$$h\nu\left[1-\frac{k}{c^2}\left(1-\frac{R}{A}\right)\right] = \mu c^2. \quad . \quad . \quad (5)$$

On the right-hand side of this equation c is constant and, therefore, μ cannot vary, which makes μc^2 constant. On the left-hand side of the equation, h is Planck's constant. Therefore, in order to satisfy equation (2), ν which we observe in the photon coming from the nebula, and which is on the left-hand side of equation (2), must have a value different from ν which the photon possessed at the moment of emission, and become a variable frequency ν^1, a function of the argument A.

Equating (2) with (5), we have

$$h\nu^1 = h\nu\left[1-\frac{k}{c^2}\left(1-\frac{R}{A}\right)\right]. \quad . \quad . \quad (6)$$

This equation shows that under an acceleration by the field of gravitation a photon keeps its velocity constant by adjusting its frequency so as to compensate for the variation due to the acceleration.

The red shift of the 'expanding universe' is an immediate corollary of equation (6), as the observed wave-length λ^1 is $1/\nu^1$, and, therefore, increases with the distance A.

It seems that the idea presented is worth discussion; I should be much interested in any comments on the subject.

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[1] Abbott, C. G., "The Newtonian Lucretius", *Smithsonian Misc Collections*, 142 (1899) Shneiderov, A. J, "The Exponential Law of Gravitation and Its Effects on Seismological and Tectonic Phenomena", *Trans Amer Geoph. Union*, 61 (1943).

Surface Tension of Solutions

IN a recent paper[1], Wales discusses the approximate relations for the surface tension of regular solutions. He concludes that the surface tension is linearly or quadratically related for ideal and regular solutions respectively to the molar volume fractions of the components.

Two facts, however, limit the applicability of these relations. (1) The omission to take into account the adsorption at the surface which is responsible for the disagreement between the relations obtained and the Gibbs equation for the surface tension. (2) The neglect of the orientation of molecules at the surface.

In a theory I have recently developed[2] both those effects are accounted for in terms of the monolayer, while the derived relations for the surface tension agree perfectly with the Gibbs equation and cover the whole range of concentrations At close values of the surface tension, relations analogous to those derived by Wells are obtained, while the surface tension for ideal solutions is linearly related to the surface molar fraction, which indicates the area occupied by molecules of the given species in the monolayer. An inspection of the benzene – carbon disulphide system, discussed by Wells, shows the carbon disulphide molecule to be oriented perpendicular to the surface.

A paper devoted to the statistical treatment of regular solutions and, in particular, to the analysis of the benzene – carbon disulphide system was ready in February 1944 and is to appear shortly in *Acta Physicochimica USSR*.

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[2] *Acta Physicochim. USSR*, 19, 176 (1944).

Plant-Growth Substances and *Penicillium notatum*

IT was considered of interest to study the effect of plant-growth substances on the production of penicillin by the mould *P. notatum*. Several experiments have been carried out using indole-3-acetic acid and α-naphthalene acetic acid. The study has included the use of various media with the Squibb strain of *P. notatum* (American Type Culture Collection). Heavy spore inocula were added to two quart bottles (flat type) containing about 300 ml. of the medium. The bottles after inoculation were kept at 23–24° C. and 80 per cent humidity. As might be expected, marked stimulatory effects of the growth-substances were found only in the cases of the simple media, such as Czapek-Dox with added brown sugar. The experiments reported refer to penicillin production in the latter medium with 4 per cent brown sugar. Addition of either of these growth-substances at the concentration of 1 part in 30,000 had no effect in a mineral and corn-steep (6 per cent) medium. The titres obtained with the simple medium plus the growth substances are higher than have previously been reported for this medium alone. The practical value of the findings is limited, however, for much higher titres are the rule with the corn-steep media. This work suggests that a part of the good results got with the corn-steep may be ascribed to its containing plant-growth stimulants; but this point has not been checked.

The results of repeated tests have been somewhat erratic because of the variation in bottles inoculated under identical conditions. Almost without exception, however, the bottles containing the growth substances have developed mature mould mats in somewhat shorter times, and the titres of penicillin (both at the same time and at comparable stages during the development of the mat) have been higher than in controls. It is not known whether this is due to a faster growth or to a greater total growth of the mould, or to an increased secretion of penicillin. It is thought that faster growth of the mat will account for the findings, for, of course, the quicker the peak concentration of penicillin is reached, the higher it will be, there being less time for the decomposition of the accumulating penicillin.

A single, complete experiment is given in the table, the titres representing the best bottle of a triplicate group. Repeated experiments gave the same indications, but not usually the same figures.

EFFECT OF PLANT-GROWTH SUBSTANCES ON PENICILLIN TITRES FROM *P. notatum* ON A SIMPLE MEDIUM

Medium	Days after inoculation	Penicillin (Florey units per ml.)
Control	6	30
Indole acetic acid, 1 in 10,000	6	50
Naphthalene acetic acid, 1 in 10,000	6	25
Control	7	35
Indole acetic acid, 1 in 10,000	7	50
,, ,, ,, 1 in 100,000	7	35
Naphthalene acetic acid, 1 in 10,000	7	40
,, ,, ,, 1 in 100,000	7	50
Control	11	28
Indole acetic acid, 1 in 10,000	11	50
,, ,, ,, 1 in 100,000	11	30
Naphthalene acetic acid, 1 in 10,000	11	30
,, ,, ,, 1 in 100,000	11	45

It is thus seen that indole acetic acid at a concentration of 1 part in 10,000 gives the quickest high titre of penicillin, whereas it is not so active at 1 to 100,000. Naphthalene acetic acid is more active at 1 part in 100,000, giving a titre peak in seven days. The two concentrations mentioned were the only ones studied, and it is likely that the optimal one has not been chosen. Work along these lines is being continued.

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Ripening of the Onion Bulb and Infection by *Botrytis* Species

THE first sign of normal ripening in the onion plant, it is supposed, consists of a local collapse at the neck, resulting in the leaf blades falling over on to the ground while several of them are still green and turgid; this can occur with plentiful soil moisture[1,2], though hastened by drought, and has been attributed (*loc. cit.*) to a softening of the tissues of the neck. The true explanation would appear, however, to be purely mechanical, and connected with the mode of development of the onion bulb. In the absence of bulbing, as in an onion plant growing in short days, new leaves emerge at regular intervals. Each leaf consists of a thin-walled hollow cylindrical leaf base surmounted by a more or less cylindrical 'blade' which is at first solid but later develops a lysigenous cavity. At the junction of the leaf base with the leaf blade a pore is found, through which the next younger leaf emerges. The neck of the actively growing onion plant thus consists of a number of very thin concentric leaf bases enclosing a practically solid core of growing leaf blades. The outermost leaf bases are dead and papery, but even the living ones have little inherent rigidity; the solid core is formed by the blade or blades of the one or two leaves next emerging. When, under the stimulus of long days, bulb development occurs, leaf emergence ceases immediately or soon according to conditions[2,3] and the three leaf initials next due for emergence become instead swollen bulb scales with practically no leaf blade[3]. The result is that after the blade of the last leaf has emerged there are no more to provide the solid core of the neck, which thus becomes a thin-walled hollow tube. This soon buckles and collapses under the weight of the green leaf blades, especially in wind or drought. Experiment has shown that removal of the central core very greatly reduces the resistance of the neck to buckling.

The common horticultural practice of bending onion plants over at the neck to hasten ripening thus appears groundless. If bulbing has not proceeded far enough to stop leaf emergence, the practice can only result in breaking or bruising the next emerging leaf blade, while if leaf emergence has ceased the neck will of itself collapse very soon, though there seems no obvious reason why this should either hasten the drying of the leaf blades or the onset of dormancy, which together accompany ripening.

Before bulbing occurs, the pore at the junction of leaf base and blade is from the earliest developmental stages of the leaf initial blocked by the tip of the subsequent leaf[3]. The last leaf to emerge after bulb development, however, has an open pore, since the next leaf initial forms a swollen bulb scale the blade of which fails to elongate. If, therefore, this last leaf emerges fully before collapse of the neck occurs, the onion plant has then a more or less open pore communicating directly by the hollow neck with the interior of the bulb. Since we have in a number of cases found the swollen bulb scales infected (apparently with *Botrytis* spp.) while the surrounding swollen leaf bases[3] have appeared healthy, it would seem that this probably provides one of the modes of infection of the onion bulb by spores of *Botrytis* spp., which constitutes one of the main problems of economic importance connected with onion culture and storage in Great Britain. Another likely path of infection is via the pores of the other (older) leaves, since these sag open as the leaves wither and thus provide pockets for the lodgment of air-borne spores and probably fairly high humidities for their germination. This would presumably lead in the first instance to infection of the swollen leaf bases rather than of the swollen bulb scales, and this is the most frequently observed condition in the early stages of *Botrytis* 'neck rot'. That infection does in fact occur via these pores is indicated by our observations of the occurrence of 'neck rot' in the greenhouse, where the plants are somewhat etiolated and the necks very much longer than under field conditions. Here the tissues of the leaf bases are killed high up on the neck near the pores, and even the whole neck rotted through at that level, before the bulb shows any obvious infection.

The above considerations provide yet another example of the importance of the cessation of leaf emergence with bulb development in accounting for the behaviour of the onion plant[2].

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Sulphonamides and American Foul Brood Disease of Bees

An editorial note in a recent issue of *Gleanings in Bee Culture* (72, 493; 1944) reports on the use of sulphathiazole in the treatment of American foul brood disease of bees by Prof Haseman, University of Missouri, Columbia Sugar syrup containing sulphathiazole fed to the bees enabled them to raise healthy brood in combs containing the scales of larvæ which had died of the disease

In 1943, Mr C. A. Ekins, of Brookwood Hospital, Surrey, sent to this Department an account of some experiments he had been carrying out since May of that year, in which sulphapyridine was being used in the treatment of five colonies of bees affected with American foul brood He continued his experiments until July 1943 (with further treatment as a preventative measure in the following spring), since which date, he reports, there has been no recurrence of the disease No evidence of disease was found when the colonies were examined in May 1944 by the local officer appointed for the inspection of apiaries under the Foul Brood Disease of Bees Order

Following upon Mr Ekins' claims of complete success with his treatment, and after consultation with him, it was decided to carry out a trial of sulphapyridine in the experimental disease apiary at Rothamsted. Accordingly, in June 1944, two colonies of bees of approximately equal strength, and headed by hybrid queens of the same age, were infected with American foul brood by feeding them a suspension of the spores of *Bacillus larvæ* in sugar syrup. The disease was allowed to run its course in both colonies until August 3, when one of them was fed 600 ml. of sugar syrup containing 3 gm of soluble sulphapyridine This treatment was repeated at weekly intervals, four doses being given in all The other colony was fed plain syrup in equal quantities on the same dates On September 8 the bees in both colonies were killed and the combs then examined. No major honey flow occurred during the period of treatment

There was a marked difference between the two sets of combs. In those from the treated colony all the recent brood appeared healthy, though somewhat scattered and irregular in arrangement. No larvæ in the early or ropy stage of the disease were found, with the exception of two individuals situated on a comb remote from the three combs forming the actual brood-nest. Scales, the formation of which normally takes about three weeks from the death of the larva, were, however, present in eight out of the eleven combs in the hive In the combs from the untreated colony many ropy larvæ were present, along with others showing the progressive stages leading to the formation of the scale.

It would appear, therefore, that during the course of the treatment the progress of the disease within the colony had been arrested, and that only healthy brood was being reared in combs where the disease had previously been established. The test was a severe one owing to the length of time which elapsed between infection and the beginning of the treatment; it was purposely not carried to its ultimate conclusion because of the lateness of the season and because of the danger of robbing by bees from other hives nearby.

It should be noted that the conditions of the experiment were not identical with those of the experiments carried out by Mr. Ekins, who combined manipulative methods with the sulphapyridine treatment, and a complete elimination of the disease, as claimed by Mr Ekins with his methods, was not obtained. The result does, however, justify the planning of future tests on a larger scale.

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Phagocytosis and Storage of Trypan Blue in the Appendix of the Rabbit

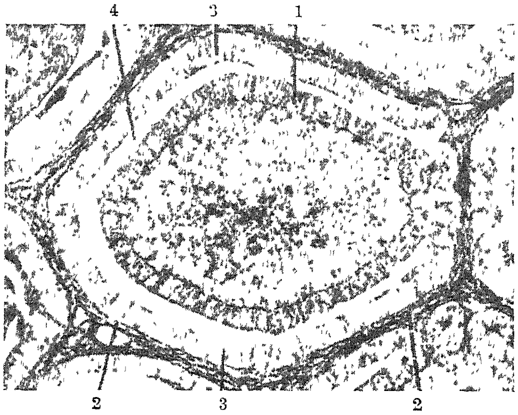
The observations of Baker and Enticknap[1] substantiate the claim of Bizzozero and Ruffer (cited by McEwan[2]) that an active phagocytosis occurs in the appendix of the rabbit, the agents concerned being large mononuclear cells present in the lymph follicles and lymph papillæ of the submucosa The following observations made on the appendices of vitally stained adult rabbits throw additional light on this process

The dye, trypan blue, was administered subcutaneously in a 2 per cent solution in distilled water and the animals were killed at various intervals after stopping the injection. The amounts of the dye used, the frequency of the injections and the times when the animals were killed are given in the accompanying table.

Rabbit	Daily dose of trypan blue (c.c.)	No of injections	Time between last injection and killing
1	2.5	1	12 hr
2	2.5	2	2 days
3	2.5	2	10 days
4	5.0	2	2 days
5	5.0	2	10 days
6	7.0	2	2 days
7	7.0	2	5 days
8	10.0	2	2 days
9	10.0	2	10 days

Following the administration of trypan blue in moderate concentration (R 1, R 2 and R 3) particulate segregation of dye particles occurred in the cytoplasm of cells in the serous coat, in reticulum cells surrounding the follicles and in certain cells of the mucosa. The dye-containing cells in the serosal coat were frankly macrophagic. Those in the peri-follicular tissue were rather smaller, but the majority of them exhibited the staining characters of macrophages. A few showed an early rosette arrangement of the dye particles often seen in monocytes. These cells were abundant in the region of the peripheral lymph sinus of the follicles, and at many sites appeared to project into its lumen. Cells of similar size and with identical staining characters occurred near the lymph channels in the mucosa. At other situations in this zone, notably around encysted sporozoa (abundant in larger or smaller groups), macrophages with a more bulky cytoplasm were electively stained, and the appearances suggested that many of them play an important part in the defence reaction of the mucosal tissues towards these parasites. The follicular lymphocytes were not affected by the dye; but numerous large moribund cells and disintegrating cell debris in the centre, and to a less extent at the periphery of the follicles, were diffusely stained (see photo).

The administration of the dye in larger amounts (R 4, R 5, R 6 and R 7) produced a marked increase in the number of dye-containing cells in the perifollicular zone and around the mucosal lymph



LONGITUDINAL SECTION OF RABBIT APPENDIX (R 5) SHOWING DIFFUSELY STAINED MORIBUND CELLS IN THE CENTRAL AND PERIPHERAL REGIONS OF A LYMPH PAPILLA MASSON'S PONCEAU-ACID FUCHSIN, × 120.

1, Epithelium of papilla, 2, reticulum in deeper part of mucosa containing lymph channels and blood vessels; 3, mucosal lining, 4, lumen of appendix.

channels. In R 5 and R 7, the animals of this series which were killed at later periods, there was, as compared with R 4 and R 6, an appreciable reduction in the number of the stained cells associated with the lymph channels in the perifollicular and mucosal regions. This reduction appeared to be due to a desquamation or migration of the cells into the lymph follicles, where the appearances indicated that some were phagocytosed among the central cells of this region. R 5 and R 7 also exhibited fine dye inclusions in the cytoplasmic processes of the perifollicular reticulum fibres, and in many situations dye particles were observed in elongated cells lying adjacent to the endothelium of the blood vessels. In all animals of this series the intensity of the stained elements around encysted sporozoa deepened.

In more intensely stained animals (R 8 and R 9), cells of macrophagic character containing fine dye particles appeared in increasing numbers within the lymph follicles. Many of these cells had presumably migrated into this situation from extrafollicular sites, but there was evidence in R 9 that dye particles had been segregated by certain follicular cells—possibly lymphocytes which had developed in a macrophagic direction as a defence reaction to the increased stimulation.

It was noted that the central parts of most of the lymph follicles contained many large mononuclear cells having all the morphological characters of macrophages but which were entirely unaffected by the dye. These cells are probably identical with the phagocytic elements (macrophages) recorded by Baker and Enticknap[1]. It may be that the relatively poor blood supply to the regions containing these cells accounts in part for their inability to segregate dye particles. On the other hand, it is possible that other activities peculiar to their situation, for example, phagocytic, incapacitate them from taking up other substances presented to them, as Cappell[3] has suggested in the case of similar cells found in lymph glands.

The above observations confirm the presence of numerous phagocytic cells within the lymph follicles of the rabbit appendix, but the majority of these are not readily stainable by means of trypan blue administered by the subcutaneous route. A renewal of the elements concerned in this process from follicular cells is indicated, and the proximity of diffusely stained moribund cells and of extracellular dye particles to the epithelium covering the lymph papillæ suggests a process of elimination at this site. It would appear that phagocytosis occurs mainly within the follicles. In this situation a true germinal or lymphoblastic core is not well established, and Crabb and Kelsal[4], following the suggestion of Ehrich[5], refer to this tissue as "lymphoid" rather than lymphatic. Latta[6] and West[7] regard the central part of the follicle as a region of cellular degeneration rather than one of proliferation. Latta[6] recorded a decrease in the number of lymphocytes and the presence of numerous moribund cells in the central parts of the follicles, and stated that this results from a local inanition due to the poor blood supply of these regions. Crabb and Kelsal[4] observed "clusters of moribund large lymphocytes resembling the 'ghost cells' of Todd and Sanford"[8] towards the periphery as well as in the central parts of the follicles, and recognized the possibility of the former site as being closely related to elimination.

While the levels of vital staining employed in the above experiments produced no obvious general upset in the animals, it is important that care should be exercised in the interpretation of results, for in this, as in other situations, the dye itself is obviously capable of producing proliferative changes in susceptible elements.

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Colour-blindness in Left Eye following an Accident

A MAN of fifty years of age, knocked down by a bus in 1942, sustained fractures of facial bones on the left side, was unconscious for ten days, saw double for six months, had electrical treatment and recovered. There were no brain injuries, but severe facial paralysis on the left side. In 1944 he was brought by a friend, Mr W. Macaulay, and proved an accurate and consistent observer. The left eye was his better eye before the accident.

Prof. Arnold Lowenstein kindly examined his eyes, with the following results R. fissure 12 mm., L. 10 mm.; L. eyelids unable to close completely; no disturbance of eye-movements; L. cornea hyposensitive; R. pupil 4 mm., L. 3·5 mm., both pupils gave immediate reaction to light, but L. reaction inconsiderable; convergence reaction to 2·5 mm. in both pupils. R. eye: fundus myopicus with inferior conus and optic colaboma between 5 and 7 o'clock; disk of pinkish colour. L. eye: 1–1·5 d. myopia; disk sharply defined, of a bluish-white colour; vessels well filled and no sheathing; atrophic excavation, small area of pigmentation round disk; otherwise fundus normal.

Usual colour names		Violet	Blue	Blue-green	Green	Yellow-green	Yellow	Orange	Red
Names used by subject	R eye	Light blue	Blue	Blue-green	Green	Yellow	Yellow	R yellow	Red
	L eye	Grey	Grey		Green		Grey	Grey	Grey

Visual acuity was corrected as follows, without correcting astigmatism: R. eye to 4/36 with $-4\cdot0$ d.; L. eye to 4/18 with $-1\cdot0$ d With these corrections he did the Ishihara test (25 plates): R. eye, all correct; L. eye, none legible whatever.

Perimeter test: R. eye normal with 1 cm. disks of red, yellow, green and blue. L. eye normal with 5 cm. disks of red, yellow and blue, but 1 cm. disk of green sufficed. No central scotoma, but red was less saturated in central area, L. eye.

Independently of Prof. Lowenstein, a colorimeter test showed that the right eye was normal but had a slight weakness in red, but the left eye was normal only for green, since red, yellow and blue were equated with greys of normally equivalent brightness.

After six to seven weeks, when the other tests were done, the right eye gave the same result, but the left eye had improved to about 1/25 normal thresholds for red, yellow and blue. This corresponded to the perimeter test, in which the left eye had 1/25 normal sensitivity to these colours.

The Edridge-Green Beads and the Holmgren Wools confirmed that colour vision was normal with the right eye, while green was the only colour seen clearly with the left eye. The colour perception spectrometer gave the result shown in the accompanying table.

The subject knew that he could see only green clearly with the left eye, and identified it as the colour he called green with the right eye.

The bearing of this case on theories of colour vision is important. It would be expected that primary colours, on any theory, might be lost independently of each other through shock or injury, and/or that colours lower in the scale of evolution, on any theory, would be retained longer after injury or shock, while those more recently evolved would recover last.

Willmer's 2-colour theory[1]. Red and violet are the only primaries. Loss of these would give total blindness; partial loss would give darkening of both ends of spectrum and proportional loss of green. The theory is not supported.

Young-Helmholtz 3-colour theory. Green might be retained while red and violet-blue were lost, but both ends of spectrum would be extremely darkened.

Walls's modified 3-colour theory[2]. Weakness of colour vision is due to shifting of sensitivity curves so that they overlap. Red and blue-violet might be lost, but both ends of spectrum would be darkened, and, since all three sensitivity curves would now overlap in the middle, 'green' would be greatly brightened and would be wholly replaced by grey. No support is given to either form of the Helmholtz theory.

Ladd-Franklin's evolutionary theory. If yellow and blue are lost, then both red and green must be lost, too, since they evolved later and depend on the integrity of the blue and yellow sensations.

Edridge-Green's theory. The dichromic form of colour vision discriminates the ends of the spectrum as yellow and blue, and evolves out of monochromic vision, in which only grey is seen. It develops into trichromic colour vision, in which green is added between yellow and blue. In the case reported green is distinguished from the ends of the spectrum, which are both grey, and it lends no support to the theory.

Hering's 4-colour theory. Blue and yellow, and/or red and green, could be lost while the corresponding brightness sensations remained. Green could be retained, as in the case reported, while red, yellow and blue were lost, if the dissimilative process of the red-green pair became checked at the neutral point and could not proceed towards red.

Houstoun's modification of Hering's theory[3]. The changes from red to green and from yellow to blue depend on the proportions of red to green and of yellow to blue responses. Yellow and blue light might both excite yellow and blue responses equally frequently, giving yellow-blue blindness. Green light might still excite the normal preponderance of green over red responses, and red light excite both red and green responses equally often, so that the normal change over failed to proceed further than the neutral point. This would explain the case described.

In general, it may be concluded that the case described strongly negates all colour theories except Hering's, while Houstoun's modification of this theory is the most fully supported.

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Jan. 10.

[1] *Nature*, 151, 213, 632 (1943), 152, 190 (1943).
[2] Walls, G. L, "The Vertebrate Eye", 88*ff* (1942).
[3] Houstoun, R A, "Vision and Colour Vision", ch 14 (1932)

Cannibalism in *Aurelia*

Planulæ of *Aurelia* were washed out of the brooding pits of the mother medusa and allowed to settle down in small dishes about 35 mm. wide and about 7 mm. high (very suitable for microscopic investigation). These dishes were gently placed in large basins (capacity about two litres) and left undisturbed until the larvæ got hold of their substratum. This usually took about 36 hours, after which time the basins were placed under running sea water, thus giving the larvæ access to their natural food. However, it was observed that certain scyphistomæ attacked their neighbours. The 'aggressor' would extend its body until the mouth would reach the 'victim'; then the mouth would be widened so as to enclose the greater part of the victim, which would resist and stick firmly to the substratum. A struggle would take place, but at last the whole body of the victim would be taken in the cœlenteron of the aggressor. The scyphistomæ usually bud off a number of individuals which separate and settle down round the mother-scyphistoma, but cannibalism has not been observed among members of such a group.

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Nov. 30.

RESEARCH ITEMS

Secondary Sexual Characters in Beetles

THE great development of horn-like outgrowths in male Dynastid beetles is a conspicuous secondary sexual character. What these horns are used for has long attracted attention and excited speculation. William Beebe (*Zoologica*, 29, Aug 1944) records observations made in the New York Zoological Society's Laboratory at Caripito, Venezuela, on the elephant beetles *Megasoma elephas* and *Strategus aloeus*. In both these species he finds that the males use their cephalic and thoracic horns for fighting with each other. The initial stimulus appears to be the advent of the rainy season. The technique of fighting seems to be the same for both species first an effort to unbalance the opponent by tripping, and then by ventral attack with the anterior horn so as to throw him on his back. It is interesting to note that Charles Darwin, in the first edition of "The Descent of Man", claimed that the most obvious conjecture is that these horns are used by the males for fighting together But since they had never been observed to fight, he came to the conclusion that they were acquired as ornaments. Eight years afterwards, A. R. Wallace, in "Tropical Nature", expressed the view that these horns may be protective. Their presence, he says, would render it very difficult for the large-mouthed goatsuckers and other nocturnal birds to swallow the beetles It is therefore noteworthy that Mr. Beebe's observations appear to settle this disputed point, and are supported by a very convincing series of successive photographs taken of actual combats.

Intracellular Symbiosis and Vitamin Requirements of Insects

MANY insects contain symbiotic micro-organisms, usually bacteria or yeasts The organisms are intracellular and are housed in special organs called mycetoms. One function of such organisms seems to be the synthesis of certain vitamins normally required for the nutrition of the insect. M Blewett and G. Fraenkel (*Proc. Roy. Soc.*, B, **132**, 212 ; 1944) have studied this question in the case of the larvæ of two beetles, *Lasioderma serricorne* and *Sitodrepa panicea*. It is possible to sterilize the eggs before hatching and so obtain larvæ free from symbionts (sterile larvæ). Such sterile larvæ fail to grow if the diet is deficient in any one of the following components of the vitamin B complex: thiamin, riboflavin, nicotinic acid, pyridoxin, pantothenic acid. On a diet rich in vitamin B (wholemeal flour and yeast) both sterile and normal larvæ grew equally well; while on a diet deficient in vitamin B (white flour) the sterile larvæ did not grow so well as the normal ones. It was concluded that, in the case of these two larvæ, the normal symbionts could synthesize the various components of the vitamin B complex in amounts sufficient to meet the normal growth requirements of the larva (see also *Nature*, **152**, 506 ; 1943).

Nervous Control of Intestinal Function in the Earthworm

N. MILLOTT (*Proc. Roy. Soc.*, B, **131**, 271 ; 1943) has shown that the intestine of *Lumbricus*, while possessing an intrinsic nervous system of its own, is also supplied by nerves from the central nervous system. There are two such extrinsic systems of nerves, one inhibitory and one excitatory to the intestinal muscle, and the condition is thus parallel to that obtaining in the vertebrates. Further (*Proc. Roy. Soc.*, B, **132**, 200 ; 1944), Millott has shown that stimulation of the extrinsic nerve supply causes the secretion of protease by the glandular cells of the intestinal epithelium The glandular cells showed the usual histological changes associated with secretion, and an increase of protease was demonstrated in the intestinal fluid The probable course of the nerve fibres was mapped out by the usual methods of electrical exploration.

Rubidium in Algæ and Freshwater Plants

THE presence of rubidium as a 'trace element' in certain plants has been recognized since 1862, when Grandeau identified it in the ash of beet and succeeded in extracting no less than 400 gm. of pure rubidium chloride from that source. Rubidium has also been reported in various other plants and plant organs (for example, tobacco leaves) and is usually derived by the plant from traces present in the soil T. F. Borovick-Romanova, in a paper on the content of rubidium in plants (*C.R. Acad. Sci. U.S.S.R.*, **43**, 163 ; 1944), gives an account of the quantitative spectroscopic examination of the ash from fifteen different seaweeds (*Laminariales, Fucales Rhodymeniales* and *Charales*) and from fourteen higher water-plants The results, which are tabulated to show the percentage of metal in the ash and in the live plant, and also the rubidium-potassium ratio, were checked by comparison with lines produced by addition of definite quantities of barium salts. The rubidium content of the seaweeds is more than ten times that of the sea water in which they grow (2×10^{-5} per cent), while in the freshwater plants it is almost a thousand times that of the medium in which they were found. The rubidium-potassium ratio is higher in the Lammariales than in the Fucales, the average rubidium content being about 1 per cent of the ash, or 0 005 per cent of the live weight. Among the freshwater plants examined, the water-lilies showed the highest rubidium content, with 6 7 per cent of the total ash from the roots of *Nuphar luteum* (or 0 0052 per cent of the fresh weight) The plants had been collected between 1933 and 1938 from such widely separated parts as the Barents Sea, the Pacific Ocean, the Caspian Sea and the Staroselje reserve of the Ukrainian Academy. Their examination occupied the intervening years and follows a study of the distribution of rubidium in sea waters. It is a part of a survey of the occurrence of rubidium in the biosphere.

Boron in Horticulture

SINCE the first demonstration that boron is an essential element in plant nutrition, boron deficiency in a great variety of crop plants growing in the field has been recorded. Correction of boron deficiency by the use of dressings of borax is not always a straightforward matter, as in many cases the limits of boron tolerance are narrow, and A. S. Heinicke, W. Reuther and S. C. Cain (*Proc. Amer. Soc. Hort Sci*, **40**, 31 ; 1942) suggest that the application of borax even to a boron-deficient soil may induce separation of apple fruits from the trees, although this may be the result of an acceleration of fruit development as found by L. P. Batjer and M. H Haller (*ibid.*, **40**, 29 ; 1942). Usual dressings of borax are of the order of 10 lb. per acre; this amount is sufficient to control boron deficiency in the field in cauliflower, radish, beet and swede (R. H. White-Stevens, *ibid.*, **39**, 367 ; 1941), while half this amount will increase the yield of potatoes and peas on

soils deficient in boron, but where the deficiency is not sufficiently acute for characteristic boron deficiency symptoms to develop Twenty pounds of borax per acre may be harmful to spinach and carrots, and it is therefore surprising to find that indications of borax injury to eighteen-year-old apple trees did not develop until the applications of borax to the soil had reached the level of 10 lb. per tree (L P. Latimer and A P. Percival, *ibid*, 43, 21, 1943), and these damaged trees showed complete recovery in the following year.

Spraying of Fruit Trees with Growth Substances

A. E Hitchcock and P W. Zimmerman (*Proc. Amer. Soc. Hort Sci.*, 42, 141; 1943) describe the effects of spraying different fruit trees during the summer with growth substance (potassium α-naphthyl acetate). Peach and plum especially and apple, pear and cherry, to a lesser extent, responded to the treatment by delaying the opening of fruit and flower buds in the following spring. In the same journal, P C. Marth (pp. 620–628) describes how exposure of rose bushes during the winter to the vapour of naphthyl methyl acetate retards their shoot development. The magnitude of the response depends partly on the physiological condition of the bushes—'high starch' plants showing a greater retardation of shoot growth than 'low starch' ones Of theoretical interest, these experiments have a practical bearing also as they offer with rose and fruit bushes a possible method of prolonging shoot dormancy and so escaping some of the damaging effects of spring frosts, and of extending the planting season.

Verticillium Wilt of the Tomato

WILT diseases of the tomato crop are widespread, and though a useful control can be effected by maintaining the temperature between 70° and 74° F., this is not always feasible. Soil factors which affect the pathogenicity of the fungus *Verticillium albo-atrum* have been investigated by F. M. Roberts (*Ann. Appl. Biol.*, 30, 4, 327; 1943). Attack by the fungus appears to depend to some extent upon lack of competition from other soil organisms. Inoculation of the ground immediately after steam sterilization gave nearly 90 per cent infection, as against 55 per cent in unsterilized soil. Sterilization thirty-two days before inoculation resulted in only 28 per cent infection. Nitrogenous manures favoured infection; phosphate had little effect, but a deficiency of potash also encouraged the parasite.

Thermodynamic Diagrams of the Atmosphere

CARMELO DI CORLETO has discussed, under the title "Comparación Entre Los Diagrams Termodinamicos De La Atmosfera, Mas Usados En Mete rologia" (*Pub. Fac. Cien. Fisicomat*, 3, No. 1; Univ. Nac. De La Plata), the work of various investigators on the subject of variations in mass of moist air, due to ascending and descending movements. Diagrams based on the work of Hertz (1884), of Neuhoff (1900), and in more recent times of Kreitmeyer, Bjerknes, Stuve, Shaw, Refsdal and Laijtman are supplied, and the basic assumptions regarding the various conditions, and the formulæ derived from these, are briefly discussed. There is a certain amount of discrepancy in the views of different meteorologists on the results of their investigations, to which the author directs attention at the end of the paper. Criticisms of some of the diagrams are referred to, and the views of Brunt, Rothé and Refsdal on the diagrams devised by Neuhoff, Bjerknes and Shaw are quoted. Comparison of the different diagrams, made in the paper, leads to the view that the preference for any thermodynamic diagram over another is based solely on questions of convenience Any one of them provides the reader with the conditions of the air so far as atmospheric stability is concerned.

A New Representation of the Types of Nuclear Forces

IN *Revista de la Facultad de Ciencias Fisicomatemáticas*, 3, No. 29 (Institute de Física, La Plata, Argentina), Mario Bunge has a paper with the title, "Una Nueva Representacion De Los Tipos De Fuerzas Nucleares". In Section 1 he deals with the fundamental characteristics of the usual representations of nuclear forces and gives a brief outline of the theories of Gamow, Gurney and Condon, Heisenberg and others. Operators are then introduced which are formally identical with those employed in Dirac's theory of the relativistic electron, and these are able to supply an explanation of the four quantum states of the nucleon in non-relativistic approximation. By the employment of this new notation, explicit use of the isotopic spin is excluded, and it is synthesized with the ordinary spin in a single four-valent variable. The various scalar and non-relativistic potentials theoretically possible are formed by means of these new operators, and they are then applied to the problem of the deuteron. At the end of the paper there is a discussion on the advantages and the limits of the representation.

Hydrogen Bond and Diamagnetism

A CRITICAL analysis of the available data by S. V. Anantakrishnan and P. S. Varadachari (*Proc. Indian Acad. Sci.*, 20 A, 128; 1944) shows that the contribution to diamagnetic property by the methylene group CH_2 is constant, $\chi_m = 11 \cdot 69$. On this assumption, it is shown that hydrogen bonding leads to increased diamagnetism, with a susceptibility change of one unit per mol whenever structures of the type O—H . . . O=A are involved. A bifurcated hydrogen bond, as in iodic acid, apparently leads to an even larger value. The decrease of diamagnetism in water and alcohols on association is interpreted as due to an increase of the paramagnetic term associated with distortion. The interpretation of structures is considered in the paper.

Fatty Substances in Starch

CONSIDERABLE importance has been attached to the fatty constituents of starch, which interfere with the fractionation of starch and many properties of cereal starch pastes. Since the fat is not removed by a typical fat solvent such as ether or carbon tetrachloride, it has been supposed to be present in the form of esters with starch; but the adsorption of palmitic acid by starch is typical and throws doubt on this chemical theory. R. L. Whistler and G. E. Hilbert (*J. Amer. Chem. Soc.*, 66, 1721; 1944) find that the fat is easily removed from disintegrated corn starch granules by methanol, although it is difficult to extract from the intact granules. At the same time the phosphorus content of the starch is appreciably reduced, and the nitrogen content is affected to a lesser degree. All the fatty matter in corn starch (about 1 per cent) is apparently bound by associative forces rather than by primary valency bonds.

SOCIETY FOR GENERAL MICROBIOLOGY

THE inaugural meeting of the original members of the Society for General Microbiology took place on Friday, February 16, at the London School of Hygiene and Tropical Medicine, through the courtesy of the School authorities. Some two hundred members and friends of the new Society were present.

It may be recalled that the Society owed its formation to the preliminary work done by its organizing committee of some thirty members representative of the various disciplines of microbiology, which held its first meeting in London in the autumn of 1943 under the chairmanship of the late Sir John Ledingham. This Committee realized that the lack of contact between the various specializations in microbiology tended to impede the development of the science as a whole, and as the result of several informal meetings it came to the unanimous decision that the time was ripe to promote the advancement of microbiology by the formation of a society which would provide common meeting ground for those working in the various specialized fields. It was decided that the Society should concern itself with the study of bacteria, viruses, micro-fungi, protozoa and microscopic algæ in their various biological activities, it being envisaged, however, that contributions to meetings would deal predominantly with the more fundamental aspects of the study of these forms, including their physiology, nutrition, chemotherapy, systematics and ecology. Subsequent meetings were held which were presided over in turn by Dr. Marjory Stephenson and Prof. A. A. Miles, and invitations to become original members of the proposed society were sent out by the secretaries, Dr. L. A. Allen and Dr. R. St. John-Brooks, on behalf of the Committee to a number of microbiologists representative of the various fields. This appeal met with a most encouraging response, and as some two hundred and fifty favourable replies were received, the Committee felt that they had ample grounds for proceeding with the inauguration of the proposed society.

Before the opening of the proceedings at the inaugural meeting, the secretaries read a letter which had been received from the president of the Royal Society, Sir Henry Dale, wishing the young Society every success.

Prof. Miles, as chairman of the Organizing Committee, briefly recalled the steps that had led to the movement to inaugurate the Society and asked the members if it was their wish that the Society should be inaugurated on the lines indicated in the proposed rules which had been circulated. The members present, having signified their unanimous assent by a show of hands, the chairman formally declared the Society for General Microbiology to be inaugurated. The office bearers who had been proposed by the Organizing Committee for the consideration of the members of the Society were then unanimously elected. They were as follows: *President*, Sir Alexander Fleming; *Secretaries*, Dr. L. A. Allen, Water Pollution Research Laboratory, Langley Road, Watford, Herts, and Dr. R. T. St. John-Brooks, Lister Institute, Elstree, Herts; *Treasurer*, Mr. H J. Bunker; *Committee*, Dr. C. H. Andrewes, Prof. B. T. P. Barker, Prof. A. W. Downie, Dr. H. B. Hutchinson, Dr. B. C. J. G. Knight, Dr. A. T. R. Mattick, Prof. A A. Miles, Dr. Muriel Robertson, Dr. Kenneth M Smith, Dr. A W. Stableforth and Dr Marjory Stephenson. The late Sir John Ledingham had also been nominated as a proposed member of the Committee, his untimely death creating a vacancy. Prof. Miles then asked the newly elected president to take the chair.

In the course of his presidential address, Sir Alexander Fleming said that the meeting had given birth to a new body corporate, which started with a membership approaching three hundred persons, including many of the leaders in the different branches of microbiology. The meetings which the new Society would hold would bring together workers in the various branches of microbiology who might not otherwise meet and who would thus get acquainted and talking together—it was in this way that real advances were made. Thus bacteriologists, perhaps medical, perhaps agricultural, perhaps industrial; mycologists, academic or industrial; protozoologists with various tastes; or biochemists with interests in all fields were now banded together in this new Society of Microbiology. They had grown up separately, and they had been so busy growing up that they never had time to meet and discuss their common problems until now. He stressed the fact that the new Society did not mean to compete with the existing societies, but had its special aim in the correlation of fundamental knowledge regarding the minute animals and plants which formed the basis of all our studies, rather than the application of the science to the many practical problems which were better dealt with by the older societies. There was ample room for all, and the fact that there had been such a general response to the invitation showed that the Society was going to fill a definite gap. The new Society had been born into a troublous world, and the shortage of paper—an essential metabolite!—would prevent it immediately embarking on the venture of a new journal. He thanked the members present for allowing him to preside over the Society's early infancy and he hoped to be spared to watch his successors lead the Society for General Microbiology along the straight path to honour.

The subsequent proceedings consisted of short addresses by selected speakers on various aspects of microbiology. Dr. F. M. L. Sheffield (Rothamsted Experimental Station, Harpenden) read a paper which had been prepared by her colleague, Mr. F. C. Bawden, who was absent from the country, on the importance of the study of viruses to microbiology; Prof. W. B. Brierley (Department of Agricultural Botany, University of Reading) spoke on problems of the micro-fungi, illustrated by reference to *Botrytis cinerea*; Dr. C. A. Hoare (Wellcome Research Institution) chose as his subject biological races in protozoa; Prof. R. H. Hopkins discussed the biology of yeasts; Dr. A. T. R Mattick (National Institute for Research in Dairying, Reading) spoke on fundamental problems in dairy bacteriology; Dr. Marjory Stevenson (School of Biochemistry, University of Cambridge) took as her theme "Levels of Microbiological Investigation" and Dr. W. R. Wooldridge (London School of Hygiene and Tropical Medicine) read a paper dealing with the contribution of veterinary science to microbiological knowledge.

In concluding the business of the meeting, provisional rules were adopted and an annual subscription of one guinea was authorized—this amount to be adjusted later on when the journal of the Society came into being.

ABSORPTION, EXCRETION AND LOCAL APPLICATION OF PENICILLIN

THE well-known rapid absorption of penicillin when it is given subcutaneously or intramuscularly and its rapid disappearance from the blood and excretion by the kidneys was mentioned in an earlier article (*Nature*, 677, Nov. 25, 1944). J. H. Humphrey (*Nature*, 765, Dec. 16, 1944) concluded from a study of two cases of abortion with extreme oliguria that, when there is no significant renal excretion of penicillin, it is slowly inactivated in the body. Sir Alexander Fleming (*Lancet*, 620, Nov. 11, 1944) describes, with illustrations, the micromethods which he has devised for the estimation of penicillin in the blood serum and other body fluids. In the same issue of the *Lancet* (p. 621) Sir Alexander Fleming, M. Y. Young, J Suchet and A. J. E. Rowe record their work on the penicillin content of the blood serum after various doses have been given subcutaneously, intravenously and intramuscularly, either as single injections or by continuous drip.

The results confirm the fact that penicillin is rapidly absorbed aft r intravenous or intramuscular injection, disappears rapidly from the blood and is rapidly excreted in the urine. After three-hourly doses of 15,000 units, the amount of penicillin in the urine is such that it can be diluted 1,000 times or more and still inhibits the standard test Staphylococcus The urine of one patient who had had four injections of 15,000 units at intervals of ten minutes contained at one time just after the last injection so much penicillin that it could be diluted 20,000 times before its bacteriostatic power disappeared. Penicillin appeared in the blood a few minutes after a subcutaneous or intramuscular injection, so that little is to be gained by intravenous administration. On the other hand, little time must be lost, because the rate of disappearance from the blood does not differ markedly after either intravenous or intramuscular administration. Measurable penicillin disappears from the blood "somewhat as follows" after it is given intramuscularly: 15,000 units in 2–3 hours, 20,000 units in 3 hours, 35,000 units in 4 hours, 50,000 units in 4–5 hours, 100,000 units in 5–6 hours. Thus continuous bacteriostatic power can be obtained in the blood much more economically by smaller doses such as 15,000 units than by larger doses such as 100,000 units. Six doses of 15,000 units every two hours (90,000 units) will maintain bacteriostatic powers in the blood for 12 hours, while a single dose of 100,000 units will maintain it for only 5–6 hours. It may not be possible, however, to give frequent injections, and sometimes a high concentration in the blood may be desirable for only a few hours; for example, during operations through septic tissues. The most economical hospital method of administration seems to be by continuous drip, intramuscular drip being in practice the best. Much more work is required to decide whether it is better to maintain a constant low level of penicillin in the blood or to have a very high level for a short time after the injection, followed by a period of very low level before the next injection. Clinically both systems have worked excellently.

Several methods of giving penicillin intramuscularly have been described. H. L. Milles (*Brit. Med. J.*, 118, Jan. 27, 1945) describes one such method of giving it over periods as long as four days. In the same issue (p. 122), C. E. Last describes another method for continuous and accurate intra-muscular administration, and F. M. Berger (p. 116) describes a method of preparing penicillin for systemic administration, the product being, he found, effective, non-toxic and painless.

In the earlier note in *Nature* referred to above, the experimental attempt to keep penicillin in the body by giving *para*-amino-benzoic acid as well was mentioned. This substance apparently delays the passage of penicillin through the renal tubules. The *Lancet* (760, Dec 9, 1944) notes another method of economizing it by incorporating it in an oily excipient designed to delay its absorption. Vegetable oils have been tried for this purpose, but have not been satisfactory. M. J. Romansky and G. E. Rittman (*Science*, 100, 196; 1944) have, however, had some success with mixtures of peanut oil and beeswax, which have been also used for prolonging the action of histamine and heparin. Dispersions of penicillin in this mixture retained their potency for 30–62 days either at 37° C., at room temperature or in a refrigerator. Injection of 5,000–10,000 penicillin units in 1 c.c. of this oily fluid into rabbits maintained an inhibitory level in the blood for 6–12 hours, as compared with 2 hours for the same dose of penicillin in saline. Injection of 41,000–66,000 units in 2–2·4 c.c. of beeswax oil into three human volunteers gave, it is said, "demonstrable blood levels for 6–7 hours and penicillin was present in the urine for 20–32 hours after the injections". There was no local pain or irritation. One dose of penicillin in beeswax oil was given to twelve patients with gonorrhœa and eleven were cured. Later a single injection cured fifty-three others (*Bull. U.S. Army Med. Dept.*, 1944, Oct., p. 42, quoted by the *Lancet*).

Because penicillin is thus rapidly excreted and because the supply of it is, in Great Britain at any rate, still limited, the need for economy of it has led to investigation of the value of local, rather than systemic, administration (*Brit. Med. J.*, 699, Nov. 25, 1944). H. B. May (*Brit. Med. J.*, 817, Dec. 23, 1944) reports on its use in private practice, concluding that the general practitioner will use penicillin creams more often than other preparations of it and that these should be made readily available; patients could use them themselves. H. B. May and D. Stern (*Lancet*, 83, Jan. 20, 1945) describe a rapid method for testing the sensitivity of organisms treated with antiseptic creams containing either penicillin, propamidine, sulphanilamide, gentian violet, proflavine and other dyes. Another method of local application is by means of the penicillin pastilles for infections of the mouth and throat described by A. B. MacGregor and D. A. Long (*Brit. Med. J.*, 686, Nov. 25, 1944, and *Nature*, 201, Feb. 17, 1945). These authors had unsuccessfully tried sprays for acute tonsillitis. They found that a slowly dissolving pastille with a gelatin base, prepared without excessive heat replaced by another when the first had dissolved, kept the saliva fully bacteriostatic. The standard dose adopted was 500 units in each pastille. The flora of the condition being treated, as well as the general flora of the mouth, were markedly affected. Prof. L. P. Garrod (*Brit. Med. J.*, 528, i; 1944) has noted that most of the bacteria found in the mouth are sensitive to penicillin. The penicillin pastilles seem to have controlled the oral sepsis in the relatively few cases treated by MacGregor and Long. The symptoms of Vincent's gingivitis (twenty-five cases), the treatment of which by other methods

had been unsatisfactory, cleared up the most rapidly of all. Both *Treponema vincenti*, the cause of this disease, and the symptoms, disappeared in 24 hours, and within five days the ulcerated areas had cleared up so well that the treatment was stopped. No recurrence had been noticed up to 3½ months later. Acute hæmolytic streptococcal tonsillitis (seventeen cases, including four cases of scarlet fever) seemed to respond clinically to the pastilles and the effect on the throat flora seemed to be rapid. Carriers of these streptococci (twelve cases) became negative during treatment, but when the pastilles were stopped, the infection reappeared. This method of using penicillin is clearly promising and, as these authors say, more work on it is required. It certainly seems more promising than the use of sulphonamides in the form of lozenges, for Capt. A. F. Hayden and Lieut.-Colonel J. W. Bigger (*Brit. Med. J.*, 81, Jan. 20, 1945) conclude that these are not satisfactory for the prevention of respiratory tract infections, including coughs and colds.

Yet another means of local application of penicillin are the penicillin lamellæ for eye affections described by Wing-Commdr. J. C. Neely and Squad. Leader A. G. Cross (*Lancet*, 85, Jan. 20, 1945). These authors noted that solutions of calcium and sodium penicillin deteriorate, even at 0° C., and tend to become infected with organisms insensitive to penicillin. They devised lamellæ made with lactose, the use of which in a small number of cases suggests that they are as satisfactory as penicillin drops. They retained their potency for two months at room temperature. Gelatin lamellæ rapidly lost their potency. In an Annotation in the same issue, the *Lancet* (p. 92) remarks that expectations of the value of penicillin for eye infections may not be realized, but that it is the drug of choice for gonococcal ophthalmia neonatorum, and that it is valuable for chronic ulcerative blepharitis, acute gonococcal iritis and for severe infections and war wounds of the eye (given as an irrigation of the anterior chamber). On the other hand, Sir Arnold Sorsby and E. Hoffa (*Brit. Med. J.*, 114, Jan. 27, 1945) conclude, after treating forty-seven infants suffering from ophthalmia neonatorum due to the gonococcus and other organisms with penicillin drops in various concentrations, that penicillin, if it is in adequate concentration, appears to be effective against all the organisms which commonly cause ophthalmia neonatorum, and that the results obtained with it are of the same order as those obtained with the sulphonamides.

Penicillin, indeed, seems to have many advantages over the sulphonamides, its lack of toxicity being one of the greatest. The *Lancet* (55, Jan. 13, 1945) reviews research on the penicillin treatment of gas gangrene (see also *Nature*, 677, Nov. 25, 1944) and quotes work which indicates that penicillin is superior to the sulphonamides for the treatment of this condition. Its precise value requires, however, further elucidation. G. H. Tee (*Brit. Med. J.*, 118, Jan. 27, 1945) reports on the treatment of one case of meningococcal meningitis with penicillin, suggesting that, although penicillin given intramuscularly may not normally get into the cerebro-spinal fluid, it may do so under the abnormal conditions of meningitis. R. E. Rewell, in the same issue (p. 119), describes the treatment of one case of internal hydrocephalus, arising as a complication of pneumococcal meningitis, with penicillin and sulphathiazole. All cases of pneumococcal meningitis should, this author thinks, be given penicillin as soon as possible. G. LAPAGE.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

THE twenty-fourth annual report of the British Electrical and Allied Industries Research Association (E.R.A./T 352) summarizes the work which has been carried out during the year ended September 30, 1944, and again lists, by titles, the various research reports which have been issued during the year. The work is reviewed under the same eighteen major classifications as last year, among which dielectrics, electric control apparatus, and surge phenomena are prominent. The work of the Association has been carried on during the year by 111 active technical sections, committees, sub-committees and panels, and seventy technical reports on various subjects have been issued as compared with seventy-five in the previous year.

Two outstanding matters mark the conclusion of the Association's year. The first is the retirement of the director, Mr. E. B. Wedmore, and the second is the project for the establishment of new laboratory accommodation at Leatherhead. In view of the necessary expansion of research programmes and the need for achieving results in advance of the practical developments to which they apply, it is becoming increasingly evident that the limiting factor will be the shortage of adequately trained personnel, a condition which can only be relieved adequately by even more extensive pooling of problems of common interest. The Association has now secured control of some forty-seven acres of land at Leatherhead at a cost of about £25,000. Designs for the new laboratories, plant and office accommodation are in the hands of Mr. H. J. Rowse, who has already spent considerable time studying the nature of the activities of the Association's staff, so that the building arrangements may foster and facilitate their work. Plans will be ready for consideration at an early date.

Further diminution of enemy action in the London area and smoother working of industrial organizations to take care of war requirements has made possible some increased activity of committees, both those indirectly connected with war products and those concerned with essential contributions of the E.R.A. to all sections of the industry.

The latest agreement with the Department of Scientific and Industrial Research was due to terminate at the end of the year covered by the present report; but the agreements have been extended for a maximum period of two years. In doing so the Department restored the sliding-scale grant to the £1 for £1 basis. It has become apparent that many influential persons in the electrical industry who are not closely in touch with the details of technical and scientific developments are not fully informed of the nature and importance of the use that is made of the Association by the industry. To remedy this, and for the information generally of interested parties, a descriptive illustrated brochure entitled "Co-operative Electrical Research" (ERA/R619) has now been prepared and issued. This brochure deals with the past, present and future of electrical research, the activities of the E.R.A. and its association with other bodies in the industry, and an outline of some of the major researches carried out by the Association.

A detailed account of the technical and scientific activities of the Association during the year is given in the body of the report under numerous sectional head-

ings. The co-ordination of all research work connected with the applications of electricity to agricultural and horticultural work is now almost complete: plans have been prepared during the year for the establishment of a field station associated with the University of Reading, and a working liaison has been established with the Scottish Hydro-Electric Board.

Special attention has been given to research required for the further commercial development of gas-blast circuit breakers. The electric control apparatus section has prepared a further important series of reports for dealing with industrial explosion hazards. The importance of work on the creep of steels has been recognized by expansion of the scale of working at the National Physical Laboratory, and some success has been achieved in applying similar ideas in the study of insulating materials subjected to continued high mechanical stresses at working temperatures, a subject representing practically an unworked field until tackled by the Association.

Continuous attention has been given to the examination of new insulating materials and to the research necessary for their standardization, and generally to improvements in methods of selection and testing. The practical value of applying modern statistical and other scientific methods in the study of electricity supply technology is receiving increasing recognition, and when the War ends will, no doubt, be pursued on a more adequate scale. Several notable reports have been issued during the year applying to surge phenomena, transformer design and meter jewels. Work on interference with communication circuits which applied mainly to particular war products has led indirectly to an important new development affording a scientific basis for the design of ignition systems adapted to all types of engines and to varied working conditions.

CERAMIC SEQUENCES AT TRES ZAPOTES, MEXICO

THE second season's work of the National Geographic–Smithsonian Institution joint archæological expedition to southern Veracruz in 1940 has now been described in Bull. 140 of the Bureau of American Ethnology*. Bull. 139, giving an account of the 1939 season's work by G. W. Weiant, has already been noticed in *Nature* (July 22, 1944, p. 124). The aim of the 1940 work, by Philip Drucker, was to follow up the preliminary exploration of 1939 with careful stratigraphical excavations, upon which a ceramic sequence could be based. The results indicate two considerable alterations in Weiant's succession. The evidence is not absolutely conclusive on every point, but it is sufficient to confirm the suggestion made in the previous notice that his publication was premature.

The chief result of the 1940 work was to mark the essential unity and continuity of the Lower, Middle and Upper Tres Zapotes 'periods', which are renamed 'phases' to emphasize the point, and to separate Weiant's Upper period into a true Upper Tres Zapotes phase and an unconformable "Soncautla Complex", consisting of cremated burials (the "cremated burials in covered bowls" of the previous notice) intruded into deposits of the Upper phase. The Tres Zapotes period, *sensu stricto*, is shown to cover an occupation of long duration, after which the site was abandoned, and later used for the Soncautla burials for a short time. So far, the picture is entirely convincing; but Drucker also points out that he cannot confirm Weiant's division of the Middle period into *A* and *B* stages, admitting at the same time that this may be due to the absence of *A* deposits from the places excavated by him.

Much of the material found in the 1940 work consists of sherds, and this has imposed a simpler system of classification than Weiant's, in which a relatively small number of wares are based on characteristics of slip, vessel shape and paste. The distinguishing features of the Lower, Middle and Upper Tres Zapotes phases are clearly pointed out in terms of these wares. The figurines are divided into three main types; the first to appear, which persisted throughout, are hand-made and mostly solid, whereas the other two are found in the Upper phase only, one being hollow moulded and the other large and elaborately modelled by hand, with jointed limbs.

A tentative chronology of the site is sketched out, and in this connexion there are two strong indications of an early date in the complete lack of metal and of Plumbate and Fine Orange wares. The Lower Tres Zapotes phase is shown to be linked with the early Lowland Maya, to the exclusion of the early Highland cultures such as those of Monte Alban and the Valley of Mexico It is suggested that it was in existence in the first century B.C. The Middle phase is essentially one of transition, but the Upper is marked by a large increase of Polychrome sherds, and the introduction of some new elements which, it is conjectured, may have diffused from Teotihuacan. The date of the close of the Tres Zapotes occupation is estimated in round figures as A.D. 1000. This was followed by a period long enough for the accumulation of a certain amount of humus, after which came the Soncautla burials, which are very tentatively ascribed to the thirteenth century.

This bulletin shows a very considerable improvement on No. 139 in the provision of scales on illustrations and plans. Three misprints in references to plates were noticed: plate 18 at the top of p. 41 should be 16, Plate 10 at the bottom of p. 43 should be 14, and plate 56 on line 9 of p. 84 should be 59.

G. H. S. BUSHNELL.

* Smithsonian Institution · Bureau of American Ethnology. Bull. 140: Ceramic Sequences at Tres Zapotes, Veracruz, Mexico. By Philip Drucker. Pp. ix+155+65 plates. (Washington, D C.: Government Printing Office, 1944) 50 cents

FORTHCOMING EVENTS

Saturday, March 17

BIOCHEMICAL SOCIETY (at the Middlesex Hospital Medical School, London, W 1), at 2 p.m —Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St James's Park, London, S W 1), at 3.30 p m.—Mr A H Lloyd "British Machine Tools during the War" (Annual Lecture).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, South Kensington, London, S W.7).—Mr. L. V Chilton First Renwick Memorial Lecture.

Tuesday, March 20

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1 45 p m.—Dr A C. Thaysen: "Food Yeast, its Nutritive Value and its Production from Empire Sources".

CHEMICAL ENGINEERING GROUP (SOCIETY OF CHEMICAL INDUSTRY) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p m —Discussion on "Industrial Research" (to be opened by Dr. E. W. Smith).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 15 p.m.—Sir Henry Dale, O.M., Pres.R.S.. "Nerve Endings and Chemical Transmitters", (3) "Cholinergic Action in Nerve Ganglia. Motor Nerve Endings and Electric Organs".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C 2), at 5.30 p m —Discussion on "Apprenticeship and Trainee Systems in the Radio Industry" (to be opened by Dr J Greig)

INSTITUTE OF THE PLASTICS INDUSTRY (at the Waldorf Hotel, Aldwych, London, W.C 2), at 6 p m —Mr. N. J. L Megson "Plastics at War".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C 1), at 7 p m —Mr W K Fitch "Pharmacists with the B.L.A"

Wednesday, March 21

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 12 noon —Eighty-sixth Annual Meeting.

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the INSTITUTE OF PHYSICS) (at the Royal Institution, Albemarle Street, Piccadilly, London, W 1), at 2 30 p m —Prof. H T S. Britton : "The Mechanism of Electrode Measurements".

PHYSICAL SOCIETY (COLOUR GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3 p.m —Dr. R. K. Schofield : "The Presentation of the C.I.E System of Colour Specification".

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the ROYAL METEOROLOGICAL SOCIETY) (in the large Physics Lecture Theatre at the Imperial College of Science, Imperial Institute Road, South Kensington, London, S.W 7), at 5 30 p m.—Mr. J M. Waldram "Measurement of the Photometric Properties of the Upper Atmosphere".

Thursday, March 22

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W.1), at 4 p m —Mr I. H Burkill "Abnormal Gamopetalous Flowers of the Poppy, *Romneya Coulteri*, and the way in which its Sepals Protect the Sexual Organs", Prof. D. M. S. Watson, F.R.S. "Evolution of the Elephants"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p m —Sir Lawrence Bragg, F.R.S.: "Some Physical Problems of the Solid State".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. R H. Bound : "Hydraulics for Aircraft".

Friday, March 23

ASSOCIATION OF APPLIED BIOLOGISTS (joint meeting with the GENETICAL SOCIETY) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 11 a.m. and 2 15 p.m —Symposium on "Genetical Relations of Plants and Animals to their Pests and Diseases" (Speakers : Dr. C. D. Darlington, F.R.S, Dr. J. Hammond, F.R.S, Mr. M S. Pease, Mr J G Carr, Mr. W. Black, Mr. G. Cockerham, Mr. T. J. Jenkin and Dr. C. B. Williams).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Richard Paget, Bart . "Is Human Speech Good Enough ?"

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF ELECTRICAL ENGINEERS) (at Storey's Gate, St James's Park, London, S.W 1), at 5 30 p m.—Mr. W. B Shannon, Mr. C. W. Pratt, Mr T. B. Webb and Mr W. B Carlson : "Expanded Tube Joints in Boiler Drums—with Special Reference to the Battersea High-Pressure Boilers".

Saturday, March 24

ASSOCIATION OF BRITISH ZOOLOGISTS (at the Zoological Society of London, Regent's Park, London, N.W.1), at 10 a.m.—Tenth Annual General Meeting ; at 10.30 a m.—Dr. C. F A. Pantin, F.R.S : "The Interrelationship of Biology Teaching in Schools and Universities" ; at 2 p.m.—Dr. Stanley Kemp, F R.S. : "Marine Investigations" ; at 2.45 p.m.—Dr. S A. Neave : "The Work of the Zoological Society" ; at 3 30 p m.—Mr. J C. F Fryer : "Zoological Interests of the Agricultural Research Council" ; at 4.15 p m.—Dr. E. B. Worthington : "Freshwater Investigations".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p m — Mr J. H. Ridley : "An Experimental Approach to Time Lapse Cinematography".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the SOUTH YORKSHIRE SECTION of the ROYAL INSTITUTE OF CHEMISTRY) (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Dr. U. R. Evans : "The Principles governing Corrosion Resistance in Metals and Alloys".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ENGINEER AND MANAGER—The Clerk to the Alderley Edge and Wilmslow Electricity Board, 49 Spring Gardens, Manchester 2 (March 21).

ANIMAL HUSBANDRY OFFICER—The Executive Officer, Cornwall War Agricultural Executive Committee, County Hall, Truro (March 21).

ASSISTANT VETERINARY INVESTIGATION OFFICER at the University Agricultural Advisory Centre—The Secretary and Registrar, The University, Bristol (March 24).

PRODUCTION OFFICERS IN THE DEPARTMENT OF AGRICULTURE, Government of Nigeria, for Agricultural Surveys connected with investigations of Diseases of Cocoa—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No F.3752.A) (March 24).

GRADUATE ASSISTANT to teach MATHEMATICS and SCIENCE—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middlesex (March 26)

LECTURER IN BIOLOGY in the Cardiff Technical College—The Director of Education, City Hall, Cardiff (March 28)

RESEARCH OFFICER on the staff of the Council for Scientific and Industrial Research (Division of Industrial Chemistry), Melbourne, for research work in CERAMICS—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (April 2).

LECTURER (full-time) IN CHEMISTRY in the Department of Chemistry, Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (April 7)

MATHEMATICS SPECIALIST (permanent) to teach up to Higher School Certificate and University Scholarship standard, and an ASSISTANT (temporary) to teach BIOLOGY and CHEMISTRY to Junior Forms, in the Varndean School for Boys—The Education Officer, 54 Old Steine, Brighton (April 7).

PHYSICIST (full-time) at the Radiotherapeutic Centre—The Secretary-Superintendent, Addenbrooke's Hospital, Cambridge (April 7)

LECTURER (full-time) in PHYSICS—The Principal, College of Technology and Commerce, The Newarke, Leicester (April 9).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 21)

SECRETARY TO THE SENATE—The Principal, University of London, c/o Richmond College, Richmond, Surrey (April 30)

TUTOR IN PHYSIOLOGY—The Principal, Lady Margaret Hall, Oxford (April 30)

LECTURER, and an ASSISTANT LECTURER AND DEMONSTRATOR, in the DEPARTMENT OF PHYSICS—The Registrar, University College, Cathays Park, Cardiff (April 30)

PRINCIPAL—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (May 1).

UNIVERSITY CHAIR OF BACTERIOLOGY tenable at University College Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (June 25)

TEACHER (full-time) OF PHYSICS AND MATHEMATICS—The Clerk, Northern Polytechnic, Holloway Road, London, N.7.

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield, Yorks

PSYCHOLOGIST (part-time) to the Child Guidance Clinics at Huyton and Atherton and Ashton-under-Lyne—The County Medical Officer of Health, School Medical Department, County Offices, Preston

BOROUGH ENGINEER AND SURVEYOR—The Town Clerk, Town Hall, Wallasey

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Canterbury Schools : King's School and St. Edmund's. Report on Natural History, Cornwall 1940–1944. Pp. 44. (Canterbury . King's School, 1945.) [122

Institution of Professional Civil Servants Post-War Organisation of Statistics in Government Departments. Pp. 16. (London . Institution of Professional Civil Servants, 1945) [122

The Importance of Power Unit Development. By Air-Commodore F. R. Banks Pp 20. (London : Royal Aeronautical Society, 1945.) 6*d*. [132

Aeroplane Wheels and Brakes. By J. Wright. Pp. 10. (London : Royal Aeronautical Society, 1945.) 6*d*. [132

Ministry of Agriculture and Fisheries. Bulletin No. 123 : Diseases of Vegetables. By Lawrence Ogilvie. Second edition. Pp. ii+74+8 plates (London : H M Stationery Office, 1944.) 1*s* 6*d* net. [142

Carnegie Trust for the Universities of Scotland Forty-third Annual Report (for the Year 1943–44) submitted by the Executive Committee to the Trustees on the 12th February 1945 Pp iv+62. (Edinburgh : Carnegie Trust for the Universities of Scotland, 1945) [142

Other Countries

Meddelanden från Lunds Universitetets Matematiska Seminarium. Band 6 : On a Class of Linear Transformations Connected with Group Representations. By Lars Gårding. Pp. 125. (Lund : C W. K. Gleerup, 1944.) [241

Proceedings of the California Academy of Sciences, Fourth Series Vol. 23, No. 40 : Two Extraordinary New Blind Nematognath Fishes from the Rio Negro, representing a New Subfamily of Pygidiidae, with a Rearrangement of the Genera of the Family, and Illustrations of some previously described Genera and Species from Venezuela and Brazil. By George Sprague Myers Pp 591–602+plates 52–56. (San Francisco : California Academy of Sciences, 1944) [311

Proceedings of the United States National Museum. Vol 95, No. 3180 : Studies in Neotropical Mallophaga (III) (Tinamidae No 2) By M. A Carriker, Jr Pp 81–233 (Washington, D.C : Government Printing Office, 1944.) [311

Scientific Research in India By Prof. A. V. Hill. Pp 40. (Simla . Government of India Press, 1944) [311

Indian Forest Leaflet, No 69 : A Note on the Protection of Timber from Certain Borers. By J. C. M Gardner. Pp. ii+4. (Dehra Dun . Forest Research Institute, 1944.) 4 annas ; 5*d*. [12

Commonwealth of Australia. Council for Scientific and Industrial Research. Bulletin No. 142 : A Soil and Land Use Survey of the Hundreds of Riddoch, Hindmarsh, Grey, Young, and Nangwarry, County Grey, South Australia By C G. Stephens, R. L Crocker, B Butler and R. Smith Pp 55+6 plates. Bulletin No 152 : Soil Survey of part of County Moira, Victoria ; including the Parishes of Boosey, Cobram, Katamatite, Naringaningalook, Katunga, Yarroweyah, and Strathmerton. By B. E Butler, J. G. Baldwin, F. Penman and R. G. Downes. Pp 48. Bulletin No 182 : The Effectiveness of Various Mineral Dusts for the Control of Grain Pests. By Dr. J. S. FitzGerald. Pp. 27. (Melbourne . Government Printer, 1941, 1942, 1944.) [12

NATURE

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RATIONALIZATION OF LOCAL GOVERNMENT IN BRITAIN

THE White Paper on Local Government in England and Wales during the Period of Reconstruction* may be pragmatic, but no one could claim that it is bold or imaginative. The assumption that opposition to any drastic innovation such as regional government makes such a step inexpedient during the reconstruction period may be well founded. Furthermore, it is probably true that some improvement in administration might be achieved without abandoning the main features of the county and county borough system, subject to the establishment of appropriate machinery where it is shown to be necessary for combined action by neighbouring areas. But the central, and indeed only, recommendation of the White Paper is the establishment of a Local Government Boundaries Commission The field of joint authorities is regarded as the most suitable for the development of units of administration where large areas are required, and within its limited field the proposed commission may have considerable advantages. Centralizing in one body, subject to review, all boundary questions, would promote the accumulation of an unrivalled fund of experience and enable the relations of county and county borough, of town and country, to be seen clearly and regulated as a whole. It would also be an advantage to have much of the work done on the spot with a full use of local knowledge, and if the commissioners are skilful in promoting local agreement, it should lead to substantial economies in the cost of boundary alterations.

Part 2 of the White Paper, forming the major section, is devoted to this procedure for adjustment of local government areas. It is frankly recognized that the system of counties and county boroughs cannot be static, but must be capable of adaptation by changing boundaries to meet changing conditions. The proposal to improve the effective machinery for periodic review has been hailed as a solid and promising advance, and the proposed boundary commission appears to meet the conditions put forward in the White Paper; namely, it must command public confidence; it must work smoothly and expeditiously; it should be such as to reduce to the minimum the cost of making the adjustments, and it must ensure that all the proposals affecting a county, whether for adjusting county districts or altering the boundaries between county and county, or county and county borough, are properly correlated and not considered in isolation.

It is not for this positive proposal that the White Paper is to be regarded as weak and disappointingly cautious. It is because the proposal, however sound in itself, only touches the fringe of the problem, and because the analysis of the problem is hesitant and shallow. Nowhere are the fundamental issues laid bare. There is no contribution to that fundamental thinking about the relations of local and central government which is indispensable if we are to evolve

* Cmd. 6579. (London: H.M. Stationery Office, 1945.) 4*d.* net.

machinery adequate to serve the needs of to-day, either at the centre or at the circumference. Finally, as a contribution to the education of public opinion on the issues involved, the White Paper compares unfavourably with those that have been issued on other questions such as employment policy, education, health—with all of which this issue of local government reform is closely concerned. The White Paper, for example, indicates the two main arguments for large units: that many local government authorities are too small to provide the new and extended services required in these and in other fields; and the inadequacy of the present system of local authority finance, based upon property rates, to maintain existing burdens or ensure their independence. But it fails conspicuously to point out that if regional development is inexpedient at the moment, it is on account of local prejudices which have no sound or rational basis, but which it should be the work of time and education to remove. Nor is there any reference to that scientific study of the rating system and its variations in incidence, sponsored by the National Institute of Economic and Social Research, in which Prof. J. R. and Mrs. Hicks have shown the tangle, also disclosed by the Fitzgerald Committee, which must be unravelled before the system can be brought back to life and the independent income of the local authorities substantially increased.

The White Paper, indeed, compares poorly with reports like that of the committee of the National Association of Local Government Officers on the reform of the local government structure, or of the Labour Party on the future of local government, or with Dr. D. M. Goodfellow's "Democracy and Local Government" issued by the Association for Education in Citizenship as No. 12 in the Handbooks for Discussion Groups series. While Dr. Goodfellow only deals incidentally with some of the reasons that are forcing the reconsideration of the relations between local and central government, he indicates clearly enough the weaknesses of the existing system and the questions that should be asked. His pamphlet is admirably designed to stimulate that closer discussion and wider public interest which are indispensable conditions of effective local government reform and of the continued functioning of our democratic institutions. He is concerned with the general question; and while he brings certain aspects of it into clear focus, for example, that of the entry to, and staffing of, the local government service and the reasons for regional proposals, he does not enforce consideration of the problem as an urgent practical issue in the same way that recent Government proposals have done in such fields as those of town and country planning, health and education. Moreover, it is scarcely so suggestive in regard to constructive proposals as Guy Hunter's admirable pamphlet, "The British Way in Local Rule", in the British Way series. Writing before the publication of the Beveridge Report, Mr. Hunter contributes a critical review of our present social services under local government and also anticipates strikingly some of the proposals and implications in this field of the Beveridge Report, and the White Papers on Educational Reconstruction and a National Health Service, for example.

In its scheme for educational reconstruction in Britain, the Government could not avoid some revision of the present system of local educational administration to meet the needs of a new statutory system of public education. Whether or not the proposals of the White Paper on local government are those best calculated to preserve and stimulate local interest in educational matters and at the same time secure both efficiency and a really national system, the proposal that the councils of the counties and the county boroughs only shall be the local education authorities, with powers to combine for educational purposes, is advanced from departmental considerations alone. It has no relation to the grouping that might be most profitable from a general or national point of view, and it is already evident that the proposed system offers no safeguard that the outlook and resources of the local education authorities will ensure uniformity in such a matter as the salaries and status of the teachers.

The existence of such dangers is shown very significantly in independent surveys such as McColvin's report on the public library services, and it is particularly apparent in proposals for a national health service. The Government's White Paper on health starts with the view that there is no case for departing generally from the principle of local responsibility, coupled with enough central direction to obtain a coherent and consistent national service; but it recognizes the need within the administrative structure for some largely professional body which can concern itself with the professional welfare of medical practitioners who take part in the service. None the less, for the future hospital service, it will be essential to obtain larger areas than at present, both for planning and administration. Most of the areas of the existing authorities fail to meet the essential needs of an organized area, namely: a population and financial resources sufficient for an adequate service to be secured on an efficient and economical basis; a type where town and county requirements can be regarded as blended parts of a single problem and catered for accordingly; and definition as to allow of most of the varied hospital and specialist services being organized within its boundaries, leaving for inter-area arrangement only a few specialized services. Outside the hospital and consultant service, the Government holds that existing organizations should be upset as little as possible consistent with achieving a unified health service for all. While still conducted locally with all the advantages of local knowledge and enthusiasm, they should be regarded in future as the related parts of a wider whole, and should fit in with all the other branches of a comprehensive service in their planning and distribution. To secure this, the Government proposes a new joint authority, again presumably responsible for planning from a purely departmental point of view.

The argument for some comprehensive regional plan is set forth even more cogently by Sir Arthur MacNalty in the Nuffield College paper "The Reform of the Public Health Services". Sir Arthur indicates the imperative need for a large administrative area in respect of the maternity and child welfare services, the school medical service, infectious diseases, tuberculosis, venereal diseases, cancer, rheumatic diseases, as well as hospital services and general practitioner services. He proposes to provide the co-ordinated effort between local authorities by a system of regional health councils; and there is much to be said for such an arrangement, coupled with a Government undertaking to tackle the whole problem of adapting local government machinery to modern needs as soon as circumstances permit.

In health, as in other fields, an adequate programme of reform and reconstruction cannot be executed without creating the appropriate planning machinery at the centre, and forming units large and competent enough to administer and execute the policy over areas large enough for efficiency. The debate on the Town and Country Planning Act in the House of Commons showed how urgent in that field is the need for some adjustment of local government boundaries and resources, or some further measure of Government support.

It must also be recognized that we cannot continue to frame policies for re-building, for town- and country-planning and for the re-organization of education, health and other services, without giving thought to the repercussions of such policies on the structure of local government as a whole. Constructive thought about the principles and whole relation of local administration to the central government is required. It is not sufficient to recognize that certain public services require for their efficient operation administrative areas substantially larger than those of many of the existing local authorities. We must distinguish clearly the contribution which local support and interest can make to the effectiveness of those services; and we must see that departmental proposals are duly co-ordinated and harmonized with one another and with the needs of the situation as a whole. This the report of the Liberal Party Committee on Local Government conspicuously fails to do. The report is disturbing as well as disappointing, not merely for the absence of any constructive proposals, but still more for the refusal to recognize the necessity of some form of regionalism.

Much of the material proper to an inquiry into local government reform and basic to a decision on policy has already been collected and is available in such reports as those of the Barlow Commission and the Uthwatt and Scott Committees. The facts are largely displayed already. The need now is rather for clear and constructive thinking about the facts, analysis of the evidence, the formulation of principles and policy, and the courage to take the necessary decisions to execute a reasoned policy, whether or not that appears to conflict with what may be regarded as the traditional or vested interests of a particular professional body or local council.

In the attempt to view as a whole the effect upon the general structure of local government of the changes in administrative areas which are inherent in the extension of the scope of particular social services, there must first be faced the main question: Should the present tendencies to mark out large administrative areas for each main service, mainly on purely technical considerations, be permitted to proceed unchecked, or should an attempt be made to find a single comprehensive area of large size which would serve tolerably well for the administration of all or most of the extended services? But a decision on this point of area is bound up with questions of the constitution and powers of the new regional authorities. For those there appear to be three possible types: an *ad hoc* authority, a joint authority or a compendious primary authority of the type of the existing local authority. Here again, as in the choice between an elective or nominated body, exercising either executive or advisory powers, the decision must be determined by the view we take of the relation between local and central government, and of the way in which that relation can best give expression to the democratic ideal.

The decisions to be taken do indeed depend on first principles, and whatever intermediate forms of government are evolved must conform to those principles laid bare in the Machinery of Government Report nearly three decades ago. That is what presumably is being considered *inter alia* by the Committee of Ministers and the interdepartmental committee of permanent heads of departments, which already in 1943 were understood to be at work on the machinery of government. It is with that in mind that the present White Paper on local government appears to be so disappointing; so far from laying bare the fundamental issues, it is at pains to cover them up and to temporize.

Given the assurance that the fundamental issues were really being faced and that a serious attempt was being made by the Committee of Ministers and the interdepartmental committee to arrive at a comprehensive solution and not to postpone decision or action, the proposals of the White Paper might be accepted without prejudice so far as they go. Some real effort must, however, be made to deal constructively and nationally rather than departmentally with the outstanding questions, pending the reports of these committees. It must be remembered that it is no bad thing in itself that we should retain the wider freedom of experiment at this juncture that is possible, for example, with local administration, or even with regional administration, in such fields as education and health, as compared with a fully centralized national system, where the consequences of a mistake may be so much more serious. Again, the effectiveness of local government clearly depends on the extent to which it can attract the right type of men and women and secure the wider interest and support of the community. It is part and parcel of that process of re-integration in which civil defence has already shown the way in promising experiments and on which the report of the Commission of the

Church Assembly in "The Church and the Planning of Britain" rightly laid such stress. There above all lies the real solution of the problem of town- and country-planning and the location of industry, of central and local government. Handled wisely, the new extension of the social services, as Sir William Beveridge has been quick to note, gives us opportunities of harnessing to the evolution of a constructive democracy new interests and new forces in an increasing proportion of the population. If that is to be achieved, however, there must be proceeding at the centre, the careful thought, inquiry and analysis necessary to lay down the pattern of organization within which those new interests and forces can function and find effective expression.

Regional government is now inevitable; but it is essential that it should not be a form of provincial bureaucracy, and that it should be viewed and established in the right relation to the local councils and authorities and to the central government, and that there should prevail the spirit of co-operation and goodwill without which no organization can function effectively. It should be remembered that it is the multiplicity of independent local authorities that is the problem: the local council provides and must continue to provide, as Mr. Guy Hunter points out, the local leadership, the inspiration to the citizen to make the plan for Britain a plan for his town and street; to give his service voluntarily and with zest; to see a tangible result of local rule and take his part in it. Only at this level can we hope effectively to harness to our post-war purposes, the enthusiasm and unselfishness which have found expression in civil defence; and on the local authority, too, must lie a large measure of responsibility for the execution of our plans for better education, health and other social services. Again, not only will there come locally, within the limits of the regional plan, the internal planning of the town or district, but also the capacity for experiment and variation which is so much harder for the central government to attempt.

At the regional level will come those plans which must cover a wider area, as emphasized in the debates on the Town and Country Planning Act, particularly with reference to the replanning of destroyed cities and the problem of 'overspill', or of population as in Sir Arthur McNalty's proposals for the health service. Here we should seek to achieve the proper balance between town and county, industry and agriculture, between central and local control. Finally, at the national level, under the eye of Parliament, the broad national plan and lines of policy must be determined, the balance held between regions, and the solution of legal and financial obstacles to planning found. Here alone can we look for the slow adaptation of the whole system to the changing needs of the national community, and ultimately of the world as a whole. This can never be achieved without the continuous devolution of local responsibility for the execution of policy as far as possible. If regionalism is required to provide the resources for tackling some of our urgent post-war problems, it is equally required to relieve the central government of some of its burdens. But that can only be done when there is creative thinking about the first principles of the machinery of government, and the clear enunciation of policy and the taking of decisions which will allow regional and local authorities to proceed in their own sphere with confidence. Hitherto there has been little sign of this at the centre, the Requisitioned Land and War Works Bill is the latest of a series of measures in which national planning is conspicuously absent and in which the Government has eschewed any attempt to see that departmental views and prejudices do not override the general interest even to the thwarting of a national plan.

Courage and vision are the first requirements: courage to grapple with whatever private or vested interests obstruct progress; and vision to see the possibilities of a civil or local government service fitted by training and experience to concern itself with the achievement of immediate concrete purposes. The fear of bureaucracy typified in the Liberal Party report will never allow us to achieve the possibilities inherent in a 'positive' Civil Service wholeheartedly with the people and eager in its struggle for a fuller human life. As John MacMurray has pointed out, under positive government there must be a considerable extension of local rule, and the new conception of the Civil Service and of the functions of central government depend on a lively and effective participation in self government by the general body of citizens. But without courage and the readiness to shed prejudice, we shall never achieve the forms of government which make such participation effective, and at the same time secure the continuous application of scientific knowledge and technique to the betterment of the conditions of human life. To be timid, no less than to be weak, is to be miserable.

BIOCHEMISTRY OF PROTEINS

Advances in Protein Chemistry

Edited by M. L. Anson and John T. Edsall. Vol. 1. Pp. xi + 341. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1944.) 5.50 dollars.

FEW would deny that protein chemistry, in all its aspects, is one of the most important branches of biochemistry. Not only do the proteins constitute a unique group of related compounds containing numerous types and perhaps an infinity of individuals, but also their functions are many and diverse, each type appearing to be adapted to one particular function. They form, for example, hormones, antibodies, genes and, either alone or in association with prosthetic groups, enzymes and respiratory pigments. The proteins clearly offer for investigation a wide field and a multitude of problems, the complete solution of which would probably yield the key to the elucidation of the nature of living matter. On these grounds we welcome this, the first of a series of volumes to be devoted exclusively to advances in protein chemistry. Nevertheless, when we reflect that there already exists an extensive review literature on biochemistry and related subjects, and that much of protein chemistry is inseparable from other branches of biochemistry, we foresee some danger of a considerable duplication of subjects in the various

reviews. That such a danger exists is, indeed, apparent from the present volume, which contains several articles dealing with topics which have recently been reviewed elsewhere.

It was apparently the intention of the editors to publish in each volume articles by various authors dealing with related subjects. In their preface they state that the second volume will be devoted mainly to protein nutrition, and that in the first "special emphasis is laid on proteins as they occur in nature, as components of complex biological systems". The latter statement is, however, scarcely borne out by an examination of the volume. It consists, in fact, of eight articles dealing with widely differing subjects.

As is to be expected in a volume of this kind, the articles are of varying quality and interest. Some give excellent accounts of the subjects with which they deal. As examples may be specially mentioned those dealing with immunology and muscle proteins. For those who are not conversant with the relationship of immunology to proteins, the former provides an excellent introduction. The subject and its terms are first concisely explained in such a manner as to render intelligible the description of the more recent work which forms the main subject of the article. In our opinion this is a model of what a review should be. In the same category, although dealing with a less extensive field, is the article on muscle proteins. The main subject of this is, of course, the protein myosin, and the results described illustrate the inseparability of protein chemistry from biochemistry. In myosin one encounters a protein which apparently serves a dual function, probably acting as an enzyme (adenosinetriphosphatase) and also forming the contractile element of muscle. In so far as they have been analysed, there is a striking similarity in the composition of the myosins from different species; but the author is wise not to draw the conclusion that all myosins, or even some of them, are chemically identical. Similar resemblances in composition occur among other proteins serving identical functions in different species, and, as is pointed out in the article on immunity, the more nearly related the species from which analogous proteins are obtained the greater is the serological relationship, as evidenced by cross-reactions, between them. The diminution in the serological relationship as the species diverge is no doubt due to the proteins becoming more dissimilar in composition. This suggests that the species specificity of proteins is, in general, a reflexion of the specificity in the protein forming the genic material of the gametes.

Another article deals with the structural proteins of cells and tissue and gives a brief résumé of a recent symposium on cytochemistry. But it is chiefly concerned with the results obtained by the examination by physical methods of proteins, or of structures which are believed to consist of protein, or to contain a protein component. There are, for example, a few interesting electron micrographs of structures such as sperm tails which illustrate the possibilities of the electron microscope But this must at present be regarded as morphology rather than protein chemistry.

The article entitled "The Purification and Properties of Certain Protein Hormones" is sufficiently described by its title if it is mentioned that it is limited mainly to hormones from the pituitary gland, and does not describe their physiological properties. Those who have always regarded adrenaline as a hormone will be surprised to read in the introductory sentence: "All the animal hormones which have been isolated so far are either steroids, proteins, or polypeptides". Surprise may also be felt at the prospect of the possible revival of Abel's so-called unitarian theory of the hormones of the posterior lobe of the pituitary. According to the author, however, a protein apparently possessing the characteristics of a pure substance and exhibiting both oxytocic and pressor activities has been isolated from the posterior lobe.

Short articles discuss soy-bean protein in human nutrition (this might well have been held over for the second volume), the combination of calcium with protein, and lipoproteins.

The longest, and hence the main, article of the volume is entitled "Nucleoproteins". This is comprehensive in scope, dealing with nucleic acid, nucleoproteins, protamines and histones, viruses and cytochemistry. This group of subjects undoubtedly constitutes a very attractive section of biochemistry, but unfortunately the treatment of it is marred by the author's discursive style, by the inordinate length of the sections dealing with the obscure phenomenon of the 'depolymerization' of nucleic acid and related subjects, by the over-emphasis of some details and the omission of others, and by the adoption of a descriptive method for recording deductions from the results of cytological experiments, a method which tends to elevate hypotheses to established facts. Limitations of space preclude a detailed criticism of this review, but a few specific points may be mentioned.

It is emphasized that the deoxyribosenucleic acids in the nuclei of different types of cells may not be identical, but no mention is made of Feulgen's isolation in 1937 of nucleic acid from the nuclei of rye embryos and its chemical identification as thymus nucleic acid, which has an important bearing on this point. On p. 214 it is stated that the ribosenucleic acid from the pancreas yields the same kind and proportion of bases as yeast nucleic acid. This ignores Jorpes' work (1934), which seemed to show that the purine bases were in a different ratio. In the absence of decisive evidence to the contrary, this may mean that the cytoplasmic 'nucleic' acid of all animal cells is of the pancreas and not the yeast type. The acceptance, on slender evidence, of the view that a ribosenucleic acid is present in nuclei obscures the otherwise established fact that the name nucleic acid is correct as applied to deoxyribosenucleic acid but a misnomer for ribosenucleic acid. The classification of globins as histones is incorrect. They differ in their mode of occurrence and composition as well as in their chemical and physiological properties. The old analytical data for thymus histone, reproduced in Table IV, are clearly unreliable and should be replaced by the more limited data provided by Felix (1931), which leave no doubt about the presence of sulphur. On p. 266 it is stated that chromosomes appear "to join and disjoin during separate phases of the mitotic cycle". Kossel's hypothesis of the direct conversion of complex proteins into histones and of histones into protamines, to which so much prominence is given, is improbable and has no experimental basis. Finally, the apparent acceptance of the view that chromosomes undergo extensive changes in composition during mitosis necessarily leads to the corollary that the giant chromosomes of the salivary glands of Diptera, which are claimed by geneticists to give a picture of the genetic constitution of the individual in which they occur, differ chemically from the genic material received from the sperm.

E. Stedman.

INDUSTRIAL RADIOGRAPHY

Handbook of Industrial Radiology

By Members of the Industrial Radiology Group of the Institute of Physics. Edited by Dr. J. A. Crowther. Pp. viii+203. (London: Edward Arnold and Co, 1944) 21s. net.

As Dr. Crowther remarks in the introduction to this book, a volume put together as this one is "cannot have the degree of orderly development" that is to be expected in a book written by a single person. Consequently there is a certain amount of overlapping and a noticeable disjointedness which must inevitably occur when a series of discrete papers make up one volume.

The book is timely. During the War the use of X-rays in the inspection and examination of engineering structures has increased enormously, and X-ray inspection has proved itself to be an essential process in engineering development. It is astonishing that such a wide variety of applications of X-ray inspection should have manifested themselves without the appropriate differentiated development in radiographic apparatus. This, of course, may be understandable under war conditions.

The widespread use of X-rays during the War affords a very clear pointer concerning the importance of this branch of science in post-war activity, and there can be no question that the subject will be developed intensively to take its place as perhaps the most important branch of non-destructive testing.

The Radiology Group of the Institute of Physics is indeed to be congratulated on having culled the experience of so many pioneer workers and gathered together their views in the form of these articles. In this book there is very little matter which is not instructive and the collection cannot fail to be of the utmost value to those young scientific men who are now devoting themselves to this branch of technical activity.

It is really undesirable to draw invidious distinctions between papers of such excellence as those collected together in this volume, but special mention must be made of what is perhaps the outstanding contribution by Dr. L. Mullins—outstanding in the comprehensiveness with which he reviews this subject of industrial radiography. The potentialities of the method, both present and future, are strikingly illustrated by the examples he has collected and described in his article.

Attention should also be directed to another outstandingly useful contribution made by Dr. R. Jackson. In describing his experience in the radiography of heavy steel castings, he provides information of the utmost practical value. Of particular interest is his suggestion of zoning as a method of possible standardization of radiography in relation to the inspection of steel castings. This is a subject of unquestionable importance and one that bristles with difficulties, and Dr. Jackson is to be congratulated on the courage with which he has attacked the problem.

There is also a most valuable chapter on physical principles involved in X-ray practice contributed by Mr. W. J. Wiltshire. It cannot be over-emphasized that the would-be industrial radiographer must know something of the physical principles underlying the 'tool' which he intends to use, and Mr. Wiltshire has been quite remarkably skilful in putting so much valuable and fundamental information into the short chapter available to him. The first is by no means the least important chapter in the book.

The Institute of Physics has performed invaluable service to industry in having formed a special group for the study and encouragement of industrial radiology. In sponsoring this valuable collection of lectures containing so much practical information, it has emphasized that service

The book under review is described as a "Handbook on Industrial Radiology" Some aspects of industrial radiology are not included, for example, the supremely valuable branch of the subject known as X-ray crystallography. Perhaps "A Handbook on Industrial Radiography" would have been a more generally appropriate title. V. E. PULLIN

CONTEMPORARY THOUGHT OF THE RENAISSANCE

Sociology of the Renaissance

(International Library of Sociology and Social Reconstruction.) Translated from the German by W. L Luetkens By Alfred von Martin Pp. x+100 (London · Kegan Paul, Trench, Trubner and Co, Ltd, 1944.) 8s. 6d. net.

It is something of an achievement to have written a book, even a small one, about the Renaissance without a mention of Walter Pater. But then he was a gentle creature, whereas Dr. von Martin is a little aggressive. Nevertheless, there is much of interest here for the man of science, psychologist and historian, not least because, as the author indicates, the phenomena he describes are of significance far beyond the particular period under review.

Much of the turmoil of those years, the estrangements and the efforts to compromise might well be transported bodily into our experience to-day. In fact, against a background of friction, the essential continuity of the sequence Medievalism-Renaissance-Baroque is exceedingly well brought out; and that alone is worth a great deal. Against it, however, stand a few odd contrasts An example is the note, referring to the High Renaissance, to the effect that Catholicism was more or less compelled to set the 'here and now' with its stresses and strains, in quasi-opposition to the 'hereafter' with its axiomatic harmony. So far as the *philosophia perennis* goes (and this is supposedly what matters in the present context), such a view is scarcely tenable, since, of all systems, Thomism—whatever its defects—is probably the most comprehensive yet devised, and thus capable of fusing all the various 'knowledges' into something approaching coherence. That it was temporarily decadent is neither here nor there; its potency remained, and in consequence its inherent ability to smooth out the jolts.

Meanwhile, contemporary thought and action were alike obsessed with the boundless possibilities opening up for applied science; art and technics were not seldom practised by one and the same person, notably the peerless Leonardo da Vinci. How bitterly his brother artists complained that he had deserted them for engineering. It was no mere accident that he venerated Archimedes and shunned Aristotle, a point upon which it would be good to have Dr. von Martin expound. But there is no mention of it. Leonardo ends almost immersed in numinous rapture over the problem of natural law, while the merry men of the Renaissance carried on until one of the greatest storms in human history had blown itself out. F. IAN G. RAWLINS.

RÖNTGEN CENTENARY AND FIFTY YEARS OF X-RAYS

By PROF. J. A. CROWTHER
University of Reading

WILHELM KONRAD RÖNTGEN was born on March 27, 1845. The discovery of X-rays was communicated by him to the Physico-Medical Society of Wurtzburg in November 1895; a translation of his paper appeared in *Nature* of January 23, 1896. The present year thus marks the centenary of the birth of the discoverer, and the fiftieth anniversary of the epoch-making discovery with which his name is associated. It has sometimes been suggested that the discovery of X-rays was a happy accident; but there is no doubt, from the nature of his preparations, that Rontgen had, as he himself stated, set out to see whether the electric discharge through a gas at low pressure gave out any kind of 'invisible radiation' capable of detection outside the walls of the glass tube in which the discharge was taking place. The discharge tube (an ordinary Crookes tube of the cylindrical pattern, with a flat cathode at one end, and an anode tucked away in a side tube) had been wrapped in black paper, to cut off all the visible glow from the discharge, and a primitive fluorescent screen, consisting of a few crystals of barium platinocyanide on a piece of cardboard, lay handy on an adjacent bench—barium platinocyanide being a substance commonly used at the time to detect the invisible rays in the solar spectrum. On exciting the tube by means of a small induction coil to see if the light from the discharge was properly obscured by its black paper wrapper, Rontgen found that this was, indeed, the case; but he also noticed that his primitive fluorescent screen was now glowing brightly. The discovery of X-radiation had been made.

It was as simple as that; but it was not 'accidental', unless it be regarded as a happy accident that Rontgen should have thought it worth while to investigate a possibility so remote from current physical thought that, although research into the physics of the Crookes tube was being actively pursued in some of the leading physical laboratories, no other experimenter had thought it worth while to make the very simple tests involved. Some workers had, in fact, been inconvenienced by the fogging of photographic material kept in the same laboratory as their Crookes tubes; but, finding that the trouble could easily be overcome by storing the material elsewhere, they proceeded with the researches on which they were engaged without further thought or hindrance.

Rontgen showed that the new X-radiation affected a photographic plate, and he was able to take a photograph through the thickness of a stout pinewood door separating two of his laboratories. He also noticed that a strip of beading, which had been stuck on the door panel with white lead, cast a distinct shadow on the negative; the thin layer of lead being much more opaque to the radiation than the wood itself. Thus the foundations of the science of radiography were laid.

Both for its practical importance, and for its immense value as a tool for further research, the discovery of X-rays ranks high among the germinal discoveries of physics. The power of the radiation to penetrate considerable thicknesses of materials opaque to ordinary light, and to cast shadows of structures of greater or smaller density concealed within them, caused considerable popular excitement, and had obvious possibilities. The fact that the discovery was first communicated to a medical society has been taken as an indication that Rontgen immediately foresaw its importance in medical diagnosis; though the possibility that he merely took the readiest means of establishing his claim to what was clearly a discovery of first importance cannot altogether be overlooked. However this may be, the new radiation was taken up by members of the medical profession in all countries, in Britain among the first, with a zeal and devotion quite beyond praise. The pioneers among them began work with apparatus little more effective than, and quite as troublesome as, that with which Rontgen made the original discovery. A radiograph of even such an easy subject as the human hand required an exposure measured in minutes. Gradually, however, the insistent demands of the medical radiologists for more and more penetrating power, and shorter and shorter exposures, bore fruit. With the realization that there would be a substantial market for X-ray equipment, engineers became interested in the problem, and the modern diagnostic set is capable of producing excellent radiographs of any part of the human body in a matter of seconds, and with little more trouble to the operator than would be involved in switching on an ordinary electric lamp.

Progress in the interpretation of the radiographs has been equally marked. In medicine, X-rays have evolved from an exciting novelty into a standard routine. Some of the pioneers are with us still; others, we recall, as in duty bound, lost their lives through their devotion to their work, since the dangerous nature of the radiation was not at first realized.

It is not the purpose of this brief article to sketch the story of the evolution of medical radiography, but its recent invasion of the field of preventive and social medicine deserves at least a passing notice. Mass radiography, that is to say, the routine radiography of all workers, has already begun, and will undoubtedly be extended as conditions permit. In such diseases as pulmonary tuberculosis, early diagnosis is nine-tenths of the battle, and the presence of the disease can often be identified by radiography long before any physical symptoms occur to direct attention to it. In a recent survey of some 20,000 operatives, some $1\frac{1}{2}$ per cent were found to be affected, and were sent for treatment. Thus some three hundred workers will owe their escape from serious incapacity, and possibly from a premature death, to this development of Röntgen's discovery of X-rays.

The use of X-rays in the treatment of disease has scarcely made such satisfactory progress as its use in diagnosis. Many malignant growths, sarcomas, carcinomas and the like respond rapidly to the action of radiation, and fade away under its influence as if by magic For many types of these scourges upon humanity, X-radiation, either alone or accompanied by radium radiation (which, after all, is only a kind of naturally occurring X-radiation), is by far the most hopeful treatment, and no great hospital is complete without a well-equipped and well-staffed radiotherapy department. It must be confessed, however, that there is as yet an uncertainty about the action of the rays which is very tantalizing. Complete success appears to be so near, and yet continues to elude us. The action of the X-rays on tissue cells, whether healthy or diseased, is, it must be

understood, always destructive; the possibility of using X-rays to cure disease rests on the fact that malignant cells are, on the whole, less resistant to the action of the rays than healthy tissue. Some of our troubles are undoubtedly due to the difficulty of administering a lethal dose to the malignant growth without damaging the surrounding healthy tissues. This is, primarily, a problem in physics, and the appointment of qualified physicists to the staff of the radiotherapy departments, which is now becoming general, will undoubtedly lead to some solution in due course. Probably a more vital handicap has been that little or nothing was known of the way in which the radiation exerted its destructive powers on the cell. Treatment, therefore, has had to be largely empirical. Recently, however, thanks to ingenious co-operation between physicists and cytologists, it begins to look as if a breach had been made into the problem. If so, not only may methods of treatment gain in certainty, but also X-rays may add a new chapter to our knowledge of the living cell, as they have already added more than one to our knowledge of the atom.

Industry, on the whole, was slower to grasp the utility of X-rays than the medical profession. Some small amount of radiographic testing of materials for hidden defects was carried out during the War of 1914–18, mainly in connexion with aeroplane construction, in which the importance of ensuring the complete soundness of every part justified the very considerable skill and trouble involved in making adiographs with the comparatively primitive apparatus then available. Gradually, however, the value of X-rays as a non-destructive method of investigating the soundness of castings, weldings and other industrial products received fuller recognition, and the number of industrial radiologists, in this second World War, must very greatly exceed that of medical radiologists. The demands of industry, even more effective than those of medicine, since they are backed with much larger capital, have resulted in still greater advances in the design of X-ray apparatus. Million-volt X-ray tubes, enclosed with the high-tension generator which feeds them in a single unit weighing three-quarters of a ton, are now on the market, and in heavy industry (in which they are mainly employed) are regarded as quite portable. With such an outfit, successful radiographs can be made through a 6-in. steel plate, and, under suitable conditions, cracks or flaws of no more than a tenth of an inch in thickness can be detected with certainty.

To one who began X-ray work not many years later than Röntgen's original discovery, the contrast between one of these huge but obedient 'genii of the lamp' and the miscellaneous and extremely temperamental assortment of physical apparatus with which Röntgen first revealed the existence of X-rays (and which, with a few minor improvements, served experimenters for the next twenty years or so) is astounding. By their creation, applied science has gone far to repay the debt which it owes to pure science for the discovery of the radiation. When times are again favourable, pure science will no doubt respond by using these powerful tools to make still fresh discoveries. Nor has the limit yet been reached. A two-million volt tube, some 10 ft. long, is now in operation, while another carries (for a millionth of a second) a current of 2,000 amperes at 300,000 volts; and has been employed for making instantaneous radiographs of the passage of a high-velocity shell through a 1½-in. armour plate.

Still higher voltages, accompanied by still greater penetration and power in the radiation, is promised by a new type of generator, working on entiroly novel principles, which has recently been constructed in the United States. From this machine, which has been christened the 'betatron', X-radiation at energies up to thirty million volts can be obtained. When it is remembered that the most penetrating radiation from radium is equivalent to X-radiation at only two million volts, it will be realized that the betatron carries us into an entirely novel and unexplored region of the X-ray spectrum. Such radiation will penetrate not merely the outworks, but also the central citadel or nucleus of the atom; and its effects, particularly in radiotherapy, are quite unpredictable. They may be beneficial, or disastrous; but it is evident that we cannot afford to leave them unexplored. It is greatly to be hoped that the various bodies in Great Britain, whether Governmental or voluntary, interested in radiotherapeutics, and particularly in cancer research, will make the necessary provision for British research workers (who have already done so much, often with painfully inadequate resources) to play their part in the quest.

It is natural, in tracing the consequences and developments of Röntgen's discovery, to dwell first on its more immediate applications. X-radiation was, however, one of those germinal discoveries, which are at least as important for the new knowledge which they make possible as for their direct utility. Coming, as it did, a year or so before the complementary discovery of the electron by Sir J. J. Thomson, it opened the way to entirely new regions of experimental research, including the structure of atoms and molecules, and the nature of radiation itself. It may well be that when the final balance comes to be struck, the importance of X-rays as a means of winning fresh knowledge may be judged to outweigh their more directly utilitarian merits.

A knowledge of the nature of the rays was a necessary preliminary to their intelligent application in further research. The true explanation was put forward by Stokes within a few months of Röntgen's discovery. He suggested they were electromagnetic pulses produced by the sudden stoppage of the electrified particles carrying the discharge, and therefore of the same nature as light (though probably of much shorter wave-length). So far, however, did Rontgen's discovery stand apart from the general trend of the physical thought of the time, that there was an interval in which some physicists were inclined to associate the radiation with the vivid fluorescence of the glass walls of the Crookes tube, which is an invariable accompaniment of the electric discharge. Becquerel was led to investigate whether X-rays were also given off by naturally occurring fluorescent materials. Uranium was one of the substances tested, and thus the natural radioactivity of uranium was discovered. The isolation of radium, by the Curies, followed. Thus the whole science of radioactivity may be regarded as a direct offspring, though perhaps an illegitimate one, of Rontgen's discovery.

Although Stokes's suggestion was soon generally accepted, and was supported by Barkla's demonstration that X-rays, like light, could be polarized, progress was at first slow. Such evidence as there was indicated that the wave-length of the radiation must be of the order of one ten-thousandth of that of ordinary light, and attempts to apply the diffraction

methods used in determining optical wave-lengths seemed almost hopeless. It was not until 1912, when Laue suggested that the regular spacings of the atoms in a crystal might serve as a naturally occurring diffraction grating for X-rays, that real progress was made. The suggestion was immediately verified by Friedrich and Knipping, and in the following year W. L. Bragg, by a most ingenious combination of crystallography and optical theory, succeeded in determining simultaneously the grating constant of a rock-salt crystal, and the wave-length of the X-radiation employed.

This achievement has a double significance. If the spacing of the atoms in a crystal is known, we can, from diffraction measurements, determine the wave-length of the radiation impinging upon it, and thus obtain an X-ray spectrum. Conversely, if the wave-length of the radiation is known, we can deduce the spacings or lattice constants of the crystal. Thus, in the X-ray spectrometer, crystallography has found a most powerful research tool which has given quite a new impetus to this rather old-fashioned science. The practical importance of X-ray crystallography in metallurgy can scarcely be over-estimated. Since each chemical compound has its own unique set of lattice constants, it is possible to identify, not merely the elements present in a given substance (a task for which ordinary spectroscopy or chemical analysis will suffice), but also the actual compounds which these elements form with each other, and the temperatures at which these compounds form, or at which they disappear. When the field has been fully surveyed, and the X-ray crystallographic index which is already in active preparation is completed, it will be possible to identify any crystalline compound in an alloy or mixture by X-ray analysis. Nor is the field limited to true crystals. Many long-chain organic substances are sufficiently regular in their make-up to act as X-ray gratings, and much information, valuable both on the theoretical and the industrial side, has already been obtained (to quote only one example) on the structure of the fibres used in the weaving of textiles. To understand why substances behave as they do, in terms of the position of the atoms within them, is the first step in a scientific search for new and better materials; and X-ray crystallography seems destined to play a part in industry even more important than in radiography.

To attempt to survey the part played by X-rays in atomic research would involve the recital of the greater part of the history of that part of the subject dealing with the structure of the electron atmosphere which surrounds the central nucleus and on which most of the chemical and physical properties of the atom depend. Most of our exact knowledge—and it is very exact—of the arrangement, or to be more precise, the energy-levels, of the electrons in the atom, is derived from X-ray data. It may be recalled that Moseley's early survey of the characteristic X-ray spectra given out by the elements provided the first clear demonstration of the fundamental importance of the idea of atomic number; that is to say, the charge upon the atomic nucleus as opposed to the atomic weight, which was shown to be of only secondary importance. It is interesting to notice that Moseley's results showed that four elements still remained to be discovered, and that two of these have since been identified by their X-ray spectra. It may also be mentioned that the most accurate determinations of the two fundamental physical constants, the charge on an electron and Planck's constant, are, in all probability, those derived from X-ray measurements.

The temptation to moralize on the history of the discovery of X-radiation, and its consequences, is strong; but the task may be left to the reader. Nature is full of surprises, and it is not always the most obviously desirable researches which yield the richest harvest The lone experimenter who is prepared to follow his own inspiration, even if it seems to lead him away from the main current of research, has often played an important part in the progress of science; and pure science in particular, and society in general, owe much to the inspired curiosity of Wilhelm Konrad Röntgen.

DIFFRACTION METHODS IN MODERN STRUCTURAL CHEMISTRY

IN the Tilden Lecture delivered before the Chemical Society on January 18, Prof. J. M Robertson outlined first the scope, limitations and possible future developments of the X-ray and electron diffraction methods, and then went on to consider the nature and lengths of bonds with particular reference to the results of recent diffraction studies. The emphasis throughout was on organic structures, as would be expected from one who has contributed more than any other single worker to our knowledge of the precise crystal structures of organic compounds.

In comparing the electron and X-ray diffraction methods, a number of points were brought out. The great value of the former is that it is applicable to gases and the vapours of easily volatile substances, which cannot conveniently be studied by the X-ray method. In this sense the two methods are complementary. We might add that, as regards inorganic compounds, they are complementary in another sense. In general, the same finite molecules exist in the vapour as in the crystals of an organic compound, but this is not usually so in inorganic chemistry. Electron diffraction studies of the vapours of many metallic salts and of some of the compounds of non-metals give information about the structures of molecules which do not exist in the crystalline material.

A comparison was made of the nature of the experimental data obtainable by the two methods and of the ways in which they are interpreted. To the eye the electron diffraction photograph shows merely a number of rings on a background of decreasing intensity, and their positions and intensities are estimated visually. The X-ray photograph from a single crystal, on the other hand, shows a large number of discrete spots, and the positions and intensities of these can be determined with considerable accuracy. This apparent advantage of the X-ray method is, however, offset by two complications. First, the molecules in the gas scatter independently of one another and they are oriented in all possible ways. This makes it possible to calculate the diffraction effects to be expected for any given molecular model and to compare them with those observed, the parameters in the model being varied until agreement is obtained. In the case of diffraction by a crystal, this cannot be done. In the crystal the molecules are definitely oriented with respect to one another, so that not only has the molecular model to be varied

but also the mutual orientations, and hence the intermolecular distances Secondly, it is usually impossible to utilize more than a small fraction of the X-ray data on the photographs. Apart from purely technical difficulties, which can eventually be overcome, there is a complication inherent in the X-ray method, namely, that the structure amplitude F_{hkl} corresponding to a particular reflexion is a complex quantity with an amplitude and a phase constant. From the observed intensity we can in general determine only the amplitude Except in certain cases, therefore, it is necessary to work by a trial and error method based on a probable molecular model which is progressively refined as the structure-determination proceeds. The difficulty of determining phase constants may sometimes be overcome by making comparisons of data from isomorphous compounds or by studying crystals containing heavy atoms. If we assume complete ignorance of phase constants, then all the X-ray data are summarized on a Patterson vector diagram which is directly derived from the observed intensities An analogy was drawn by Prof. Robertson between the Patterson method for X-ray diffraction and the radial distribution method for electron diffraction. Apart from the difficulty of interpreting Patterson diagrams, owing to the overlapping of peaks, there is the more fundamental difficulty that the same vector diagram (and hence the same X-ray diffraction pattern) may arise from different arrangements of atoms. The discussion of the uniqueness of the solutions of diffraction problems may appear to some chemists rather academic, especially as Prof. Robertson emphasized that a structure must always be consistent with all the other available physical and chemical evidence However, while it is true that in the case of simple structures there is seldom any doubt as to the correct interpretation of the data, it is important, as the compounds studied become more and more complex, to re-examine the fundamental theory of all methods of interpreting diffraction data.

When discussing possible future developments, Prof. Robertson emphasized the need both for making fuller use of the experimental data and for improving its range and quality. He pointed out that many of the difficulties now encountered in making precise analyses are not fundamental, "and there is no doubt that they can be overcome, largely by the proper planning and organisation of the research, which will have to be on a fairly large scale". Although hopeful that diffraction methods will eventually give information about the positions of hydrogen atoms and about electron densities in bonds, he was careful to indicate some of the difficulties of interpreting the finer details on electron-density maps. On the whole, it would seem advisable to defer drawing conclusions from two-dimensional electron-density projections, and possibly to make detailed studies of the effect of temperature on electron-density distributions in selected crystals using sections through three-dimensional summations, in order to discover the effect of the thermal movements of the molecule as a whole and of different parts of the molecule relative to one another. More emphasis might have been placed on an essential difference between electron and X-ray diffraction, namely, that the nuclei are more effective than the orbital electrons in scattering high-speed electrons, whereas the scattering of X-rays is due to the orbital electrons alone. It is difficult to see how the electron diffraction method in its present form can provide information comparable with the electron-density maps derived from X-ray studies of crystals. Also, just as the thermal vibrations in solids result in the blurring of those maps, so the greater flexibility of some molecules in the vapour state makes it difficult, or even impossible, to obtain a complete picture of the molecule by the electron diffraction method. For example, the Sn-I distance in SnI_2 can be determined, but not the I-Sn-I bond angle Provided the molecule possesses sufficient rigidity, however, quite complex structures may now be studied by the electron diffraction method, as shown by the recent work on pirylene, diphenylene and tri-(phosphonitrile chloride).

Diffraction methods not only provide information about the general configurations of molecules but also they lead to accurate determinations of interatomic distances and inter-bond angles The X-ray method, of course, gives data on intermolecular as well as intramolecular bonds, and although the weak van der Waals bonds are of comparatively little interest to the chemist, much valuable information about hydrogen bonds has been obtained from studies of crystals. A feature of modern structural chemistry is the detailed analysis of data on bond-lengths with the object of discovering more about the nature of the bonds. At one time 'chemical' bonds were regarded as either ionic or covalent, and in the latter case as single, double or triple bonds. The present view is that all bonds, other than those between atoms of the same element, have some ionic character and also that bonds intermediate between single and multiple bonds exist in many molecules. Bonds of these intermediate types are described in terms of resonance between structures with different arrangements of bonding electrons.

Prof. Robertson discussed the 'order' of carbon-carbon bonds. The C–C distances for pure single-, double- and triple-bonds are well established; 1 54 A. in diamond, 1·34 A. in ethylene and 1·20 A. in acetylene. Assuming 50 per cent double-bond character in benzene (C–C = 1·39 A.) and 33·3 per cent in graphite (C–C = 1·42 A.), Pauling, Brockway and Beach constructed a curve relating percentage double-bond character to bond-length, from which can be estimated the amounts of double-bond character of other bonds with lengths between 1·54 and 1·34 A. The more detailed calculations of 'bond order' which predict minor variations in length among the bonds in molecules such as naphthalene and coronene cannot yet be checked as the differences are of the same order of magnitude as (or less than) the present experimental errors. This illustrates the need for more precise determinations of interatomic distances. On the other hand, there appear to be some abnormal bond-lengths which cannot at present be accounted for theoretically.

Dealing with bonds between unlike atoms, Prof. Robertson mentioned the recent revisions of certain of the Pauling-Huggins radii, so long adopted as the basis for discussions of interatomic distances. Observed distances which were less than the sums of these radii were considered exceptional, and elaborate explanations in terms of partial ionic character and partial double-bond character have been put forward. With the new (higher) values for the covalent radii of nitrogen, oxygen and fluorine, many bond-lengths are now seen to be appreciably less than the sums of the appropriate covalent radii, even where there is no likelihood of partial double-bond character. The empirical relationship of Schomaker and Stevenson attributes these differences to the ionic character

of the bond, and uses the electronegativity coefficients of Pauling to correct the sums of the Pauling-Huggins radii. In other words, the fact that bonds are shorter than the sums of the true covalent radii is on this later view assumed to be due in many cases to the partial ionic rather than the partial double-bond character of the bonds. In view of the importance now to be attached to Pauling's electronegativity coefficients in discussions of bond type, it is well to remember that our difficulties in this field are an indication that we have not so far solved one of the most complex and fundamental problems in chemistry.

The early electronic theory of valency assigned electronic formulæ to many molecules, but offered no explanation either of the observed inter-bond angles or of the differences in properties between atoms with the same number and arrangement of valency electrons. As regards bond angles, it was necessary to find a way of investigating the 'group properties' of a number of valency electrons, and this problem has been solved to some extent by the methods of wave-mechanics. We are still, however, far from being able to account for the chemical properties of an atom. Although elements of a group such as the halogens, all with similar sets of outermost electrons, have certain characteristics in common, nevertheless each halogen has a distinct 'individuality' and the changes in properties do not all run parallel with the increase in size (or atomic number). Thus although the properties of the atoms are to some extent determined by their outer electronic structures, the finer differences between atoms which are similar in this respect will not be explained until we are able to take into account the effect of the nuclear charge and the remaining shells of electrons.

Until we find some theoretical way of specifying these distinctive chemical properties in terms of the structure of the isolated atom, they can only be estimated from the way in which the atom interacts with other atoms. The use of the electronegativity concept represents an attempt to deal with the problem in this way. The electronegativity coefficients are derived from experimental observations on the interactions between atoms, namely, from bond energies. The new empirical relation connecting actual bond lengths with true covalent radii and electronegativity coefficients simply expresses the fact that the difference between the length of a bond A–B and the arithmetic mean of A–A and B–B is related to the difference between the energy of the bond A–B and the arithmetic mean of the energies of the bonds A–A and B–B. Some relationship is obviously to be expected; it was not apparent earlier because incorrect radii had been assigned to three of the most electronegative elements. It is, however, relevant to inquire whether the same relationship should apply to all pairs of dissimilar atoms; that is, whether the nature of a bond is the same for any pair of atoms with a particular difference in electronegativity regardless of the absolute values of the electronegativity coefficients. It will also be necessary to inquire into the general validity of Pauling's curve relating the percentage ionic character of a bond to the difference between the electronegativities of the atoms, a curve based on the dipole moments of the halogen halides. For example, are we justified in assuming that two electrons are shared in exactly the same way between two fluorine atoms as between, say, two carbon atoms, and is the relation between bond type and electronegativity the same for atoms in a horizontal row as in a vertical column of the Periodic Table? The difference between the electronegativity coefficients of carbon and silicon is greater than that between those of, say, carbon and nitrogen, yet Pauling quotes the carbon-silicon distance in tetramethyl-silane as an example of the additivity of covalent radii.

In order that future discussions of the nature of bonds shall be put on a sound basis, it is to be hoped that some of these points and some of the experimental data will be critically examined. The results are of great general interest to many chemists, of whom relatively few may be in a position to criticize the conclusions reached by the specialist. This is one of the dangers attending the increasing specialization which is a characteristic of modern science Perhaps there is still room for a Carneades, of whose function Boyle (in "The Sceptical Chymist") wrote, "that having thus drawn the chymists' doctrine out of their dark and smokie laboratories, either judicious men shall henceforth be allowed calmly and after due information to disbelieve it, or those abler chymists will be obliged to speak plainer than hitherto has been done, and maintain it by better experiments and arguments". A. F. WELLS.

THE SCIENCE OF PLANT BREEDING

By D. LEWIS

John Innes Horticultural Institution

THAT breeding is an art and not a science is an opinion frequently expressed by many who are concerned with plant and animal improvement. Whatever they have meant by art in this generalization, it appears that, in their hands, breeding is mainly unscientific. It is certain, however, after reading Dr. Harland's report on cotton breeding in Peru[1] that, in his hands, breeding is truly scientific and as such can give good results quickly. It is scientific because measurements of the relevant characters were his standards for selection, and because genetical principles were the guide in calculating the number of plants required, and in deciding the type of breeding. Therefore, he did not rely upon the hazards of hit-and-miss intuition of the art side of breeding.

Tanguis, originating as a chance seedling in 1908, has been the main variety of cotton grown in Peru since that date. It was originally of excellent quality and yield; but subsequent contamination from crossing and seed mixing with other stocks has caused much deterioration. In 1940 Harland had the task of reviving and improving its characteristic qualities, and in three years he has increased the mean fibre length by $\frac{1}{8}$ in. above the mean for commercial *Tanguis*, and has also made improvements in ginning percentage, boll weight, colour and yield. So that in 1943, 2,100 acres were planted with his improved seed.

How was this remarkable achievement brought about? The taxonomic position and origin of the variety *Tanguis* are first considered, since these are prerequisites to any scientific breeding programme. *Tanguis* has most of the characters of *Gossypium barbadense* with the early maturity of *G. hirsutum*, as a result of which previous Peruvian workers believed it to be a hybrid. But some early work of Harland showed that it is pure *barbadense* and that the early maturity arose by selection due to associa-

tion with *hirsutum* in mixed plantations and not to intercrossing between them.

The objectives of the work, nine in number, included improvement in such characters as yield, fibre-length, colour and disease resistance. In a description of his work, Harland examines and criticizes the orthodox pure-line breeding, which has been slavishly adhered to by many breeders. The advantage of a pure line is the uniformity of the commercial product, and he concluded that the value of this has probably been overrated, at least in cotton. For example, fibre-length from single seeds was found to be almost as variable as that from commercial bales made up from plants of diverse genotypes. On the other hand, the disadvantage of early fixation of the genes (favourable and unfavourable) has sometimes been overlooked, as effective selection is then confined to the original plants and the first selfed generation. In the past, far too few original plants have been used to provide sufficient genetic diversity for selection. As Harland shows, it is necessary, in theory, to start with 1,024 strains in order to obtain eight strains which will be above the average in seven characters at the end of selection. Furthermore, when a good pure line has been found, it is not necessarily good in the majority of the environments that any good commercial plant is likely to encounter. Lack of plasticity does not allow the slight adjustments by natural selection which would occur in a mixed population.

For the purpose of maintaining a certain degree of diversity from which further selection would be possible, and also for obtaining effective results quickly, Harland abandoned pure-line breeding. No self-fertilization was practised, and mixtures of strains were propagated. Selection was started on 22,000 boll samples, each taken from a single plant, from various commercial fields. A first selection based on all characters rejected all but 2,863 of them. Ten plants of each selected strain were grown, and bulk samples of the ten plants were examined for all characters. This not only saved much labour in single-plant selection; but it also eliminated heterozygotes which, although themselves good, produce bad offspring by segregation. Forty-one strains survived these bulk tests, which after single-plant selection provided two hundred plants for progeny testing. Two thousand seedlings were raised from these, and after subjecting them to bulk and single-plant selections forty-three strains finally remained. Ten of these were propagated, giving sixty-three strains in the following year. These were mixed together and distributed as commercial seed.

Thus Harland has been able to restore the good qualities of the cotton plant in Peru, and indeed to add further improvement in a very short time while retaining genetic diversity for further selection. In grasses, mixed strains have been bred at the Welsh Plant Breeding Station and utilized with success[2]. Hitherto it has been thought that, in respect of the requirements of variation, pasture crops were different since less uniformity is necessary than in more highly specialized crops, but in view of the success in cotton the mixed strain is worthy of trial in other plants. It should be especially useful in crop plants which suffer from pests and diseases in epidemic form, when genetic heterogeneity may prevent widespread destruction.

[1] Harland, S. C., "The Selection Experiment with Peruvian Tanguis Cotton", Inst. of Cotton Gen., Lima, Peru, Bull. No. 1 (1944).
[2] Stapledon, R. G., "The Breeding of Herbage Plants, etc.", Imp. Bur. of Plant Gen., Bull. No. 3 (1931).

OBITUARIES

Prof. J. K Catterson-Smith

JOHN KEATS CATTERSON-SMITH, professor of electrical engineering at King's College, University of London, was born on December 27, 1882, and died on January 25, 1945. His father was a well-known artist who became head of the Birmingham School of Art. The son received his early education at the City of London School and then entered the University of Birmingham. Here he held the Bowen research scholarship during 1902–4 and published the results of investigations on transformers, direct current motors and rotary converters. After three years at Siemens Dynamo Works, Stafford, he returned to academic life as lecturer in electrical engineering, and after a period at the University of Liverpool became chief assistant to Prof. Silvanus Thompson at the City and Guilds of London Technical College, Finsbury.

Between 1904 and 1914 Catterson-Smith published a number of papers on the starting of motors, on commutation in direct current motors, on harmonics in three-phase networks and on the manufacture of large turbo-alternators. He also contributed to the theory of transformers, induction motors and cascade motors. In 1915 he joined the Navy in the R.N.V.R. and was sent to help enlarge the wireless station at Demerara. Upon returning to Portsmouth he took part in the new developments of thermionic radio apparatus, especially in connexion with submarines. He served at sea in submarines and was promoted to lieutenant-commander. In some of the radio and supersonic developments he and I collaborated at Portsmouth and Toulon, and in particular we solved the problem of synchronizing an electric motor with a tuning fork, in preparation for facsimile transmission. Some of this work was done at Finsbury, after he had returned to his old post. Here, also, he published papers on audio-frequency amplifier design and on the theory of intervalve transformers.

In 1918 he married Miss Rita Thom and settled down to academic life again at Finsbury; but in 1923 he was offered the professorship of electrical technology at the Indian Institute of Science, Bangalore, where Sir Martin Forster was then director. At Bangalore he spent several ardent years building and equipping new laboratories, installing heavy-current plant and inaugurating a wireless research laboratory. He founded the Institute journal *Electrotechnics* and probably wrote most of it during its infancy. He and his wife, I have been told, assisted greatly in promoting the social life of the Institute.

In 1930 Catterson-Smith was appointed professor of electrical engineering at King's College, London, in succession to Ernest Wilson. Among his original researches of this period are those on the paralleling of large transformers, and on the theory and measurement of positive and negative sequence components of three-phase currents and voltages in three-wire unbalanced networks. Then came the War and the College moved to Bristol.

In the domain of electrical engineering Catterson-Smith will be remembered for the originality of his experimental work, for the careful workmanship of the apparatus he constructed and for his lucid exposition of what may be called the physiology of electrical machines—which ranged from large turbo-alternators to electric kettles and electric toys. His was one of those minds that restlessly endeavour

to improve the operation of every machine encountered; his mental processes consisted in first gaining a thorough insight into the operation of the existent machine and then applying remedies to the weaknesses disclosed. This passion for improving and inventing continued to the end of his life. For example, during the last two years he had been working on an improved electrical tele-mechanism of great ingenuity.

In Catterson-Smith there was an unusual and happy blend of art and science. His artistic instincts called for craftsmanship and appropriateness, his scientific instincts for accuracy and efficiency. These qualities imbued all his work. In addition, he possessed a personality of great friendliness and charm. No wonder he gained the affection of all his students and colleagues. W. H. ECCLES.

Prof. James Muir

BY the death, on February 17, of Prof. James Muir, emeritus professor of natural philosophy in the Royal Technical College, Glasgow, there has passed a great teacher and a man singularly devoted to science and to the quest of knowledge for its own sake.

Dr. Muir was born in 1875, and his early interest in science was stimulated by his education at Allan Glen's School, Glasgow. On leaving school, he entered his father's business; but the influence of his school training led him to consult Prof. James Blyth, on whose advice he entered his evening class at the Technical College. Thus began a connexion with that College which was to remain unbroken throughout his life.

Muir graduated B.Sc. in 1896 at the University of Glasgow, with special distinction in engineering and astronomy, and D.Sc. in 1902, having obtained the associateship of the College in mathematics and physics in 1897, in which year he was awarded an 1851 Exhibition Scholarship at Cambridge. His researches at Trinity College, under Prof. Ewing, into the effect of temperature on recovery from overstrain were published in the *Proceedings of the Royal Society*, and he was awarded the B.A. degree of Cambridge, followed in 1904 by the M.A. Returning to Glasgow, he became chief assistant to Prof. Blyth, and then assistant to Prof. Andrew Gray at the University of Glasgow.

In 1906, on the death of Prof. Blyth, Dr. Muir succeeded to the Freeland chair of natural philosophy in the Technical College, Glasgow, and he entered upon his duties with a boundless enthusiasm which continued during the thirty-two years which ended with his retirement in 1938.

Prof. Muir always gave foremost place to his teaching and to the interests of his large classes of day and evening students. Nevertheless, he found time to use to the full the resources of his department in conducting many valuable researches on behalf of the industrial firms of Glasgow, and during the War of 1914–18 these researches were directed to the service of the country. He willingly and enthusiastically entered into any movement for promoting the welfare of the College, such as the work of the *College Research Journal* and the re-arrangement and cataloguing of the founder's library.

Prof. Muir will always be remembered as a great teacher whose constant aim was to induce his students to think for themselves, to abhor anything slipshod and to enjoy hard work as he himself enjoyed it. The sincerity and love of truth shown in his scientific work was carried into his everyday life; 'he nothing common did or mean', nor could he compromise upon ethical principles. His students, like all his immediate colleagues, grew to look upon him with affectionate respect: they found him always approachable and eager to share and stimulate their interests. On his retirement, as an expression of their admiration and regard, his former students and colleagues founded and endowed the James Muir Prizes in natural philosophy, and presented to the College the fine portrait by David S. Ewart which now hangs in his old lecture room.

Dr. Muir's tastes were simple and his wants were few. From his student days he had a great love of the Scottish hills, and friends have most pleasant memories of holiday climbs in his company. At the time of his death he had prepared the manuscript of a text-book on physics and he was engaged on a memoir of the founder of the College. Prof. Muir was unmarried and is survived by three sisters.

Mr. F. R. S. Balfour, C.V.O.

BY the death of Frederick Robert Stephen Balfour on February 2, arboriculturists and horticulturists have lost a valued friend and counsellor. Though primarily an arboriculturist he was also a keen naturalist and a true lover of all kinds of plants. He had the advantages of having the means of travelling and of inheriting from his mother the beautiful estate of Dawyck in Tweeddale which possessed a number of interesting and historical trees. In later life he had important business interests in the City of London, and it was probably his business ability which led him to include experimental forestry plots on a large scale at Dawyck.

Balfour was born on March 11, 1875, and was educated at Loretto and Trinity College, Oxford. In his early days he spent four years on the Pacific coast of North America, and, although he was greatly interested in all the plant and animal life, it was the trees which captivated his imagination. He was familiar also with the trees of eastern Canada and the north-eastern States and had a working knowledge of the wonderful forests of south Chile. He became, therefore, a recognized authority in Great Britain on American trees, especially conifers. When he returned to Scotland he developed the collection of North American trees at Dawyck, introducing several species for the first time, his favourite being the rare *Picea Breweriana*, and trying out practically every species which could be expected to survive. In addition to his New World conifers he had also a collection of the more hardy Asiatic species mostly introduced by E. H. Wilson, whose second expedition to China he helped to finance. He had a great knowledge of British birds and was proud of his notable collection of foreign ducks and pheasants. From the economic point of view his most important contribution to sylviculture concerned the trial of promising, but as yet unfamiliar, species under forestry conditions or on the mountainside.

Balfour's published communications are scattered throughout a number of journals; his account of David Douglas, his "History of Conifers in Scotland" which covered a wide field, and a paper read recently before the Linnean Society on Archibald Menzies being perhaps the most noteworthy.

As a member of the Home Grown Timber Com-

mittee, Balfour was sent to France as liaison officer to the French Government during the War of 1914–18, with reference to the supplies of timber He was one of the founders and remained a most active member of the Roads Beautifying Association, being at his death chairman of the technical sub-committee. His wide love of plants was shown by his zeal in supplying material for figuring in the *Botanical Magazine*.

Balfour had been a fellow of the Linnean Society for many years and had served on the Council of the Royal Horticultural Society, the latter bestowing on him in 1927 its highest award. He had been a member of the King's Bodyguard for Scotland since 1900 and was made C.V.O. in 1944. His other interests included history, architecture and music, he himself possessing a fine baritone voice. But no notice of him would be complete without emphasis on his exceptional courtesy and charm, which were due largely to his understanding and sympathy and to the genuine pleasure it gave him to do good to his fellow-man.

A. D. COTTON

WE regret to announce the following deaths

Mr F Bligh Bond, formerly director of excavations at Glastonbury Abbey, on March 8, aged eighty

Mr. G. V. Boys, secretary of the Institution of Naval Architects since 1935, on March 15, aged fifty-one.

Sir Thomas Lewis, C.B E., F.R.S., physician-in-charge of the Department of Clinical Research at University College Hospital, London, on March 17, aged sixty-three.

Mr P. W. Paget, a technical assistant of Marconi during his early work in England from 1896 onwards.

Prof Stanisław Zaremba, sometime professor of mathematics in the University of Cracow, and a member of the Polish Academy of Science, aged eighty-one.

NEWS and VIEWS

Chair of Biochemistry at Sheffield: Prof. H. A. Krebs

THE University of Sheffield has conferred on Dr. H. A. Krebs the title and status of professor of biochemistry in recognition of his eminence in the world of science. Dr. Krebs was awarded the degree of M.D. (Hamburg) in 1925 and that of M.A. (Cambridge) in 1935. He held the post of research assistant at the Kaiser Wilhelm Institute for Biology, Berlin-Dahlem, during 1926–30 under Prof. Otto Warburg. After further experience in Germany he became a Rockefeller research student in the Biochemical Laboratory, Cambridge (1933–34), demonstrator in biochemistry at Cambridge (1934–35) and lecturer in pharmacology at Sheffield (1935–38). In 1938 he was appointed lecturer in charge of the newly created Department of Biochemistry in Sheffield, and attracted to his department research workers from both Europe and America. He is a naturalized British subject, and during the War he has given valuable service in connexion with diet and nutrition. His main contributions to biochemistry are in the field of intermediary metabolism. He showed that the synthesis of urea in the mammalian liver is catalysed by ornithine. This observation led to the formulation of the 'ornithine cycle', according to which ornithine, citrulline and arginine are intermediate stages in the synthesis of urea. His work on the oxidation of carbohydrate in muscle showed that this metabolic process, too, is a cyclic one (known as the 'Krebs cycle'), where a series of organic acids arises periodically.

Prairie Regional Laboratory, Canada: Prof. R. K. Larmour

PROF. R. K. LARMOUR, professor of chemistry in the University of Saskatchewan, has been appointed director of the Prairie Regional Laboratory which is to be built in Saskatoon by the Canadian National Research Council. Prof. Larmour served in the War of 1914–18, and following his return from overseas, he graduated from the University of Saskatchewan and carried out postgraduate work in the University of Minnesota, where he was Shevlin fellow. He joined the staff of the University of Saskatchewan in 1927 and has remained there ever since except for a short period when he occupied the chair of milling industry at a mid-western American university. Dr. Larmour has a high reputation in the field of grain research. The Prairie Regional Laboratory will be concerned primarily with investigations into the utilization of agricultural crops It will be provided with facilities to undertake all phases of laboratory and pilot-plant investigations in this field.

Colonial Development and Welfare Bill

THE essential feature of the new Bill dealing with Colonial development, which should be of interest to administrators, scientific men and technologists, and all who are concerned with the welfare and advancement of the British Colonial possessions, is that it represents a notable extension of the Colonial Development and Welfare Act of 1940. The extension concerns both the annual provision of funds and the period over which they will be available. Put briefly, whereas the Act of 1940 made available a sum of £5,000,000 per annum for development and £500,000 per annum for research, until 1951, the new Act makes available, unless "Parliament otherwise determines", a sum of £120,000,000 for all purposes during the period 1946–56. A commendable elasticity, which all who are responsible for new schemes whether of research or development will appreciate, is a feature of the new enactment. Thus it is explicitly stated that no time limit is imposed on schemes of research and investigation and up to £1,000,000 can be spent on such schemes in any one year. For all purposes, up to £17,500,000 may be expended in any one year.

Few will disagree with these measures. Substantial help for the Colonies has been long overdue. Now, it is reasonable to hope that definite schemes may not only be planned and set in motion but also actually carried through to fruition. Readers of *Nature* are already familiar with the very diverse developmental, constructional, sociological and research projects which require and are receiving attention under the Colonial Development and Welfare scheme. In particular, it may be pointed out that members of university staffs and of the teaching profession in Britain, as also in the Dominions and in the Colonies,

have a very real responsibility for the successful outcome of the new Bill. The key to success can be stated in a single word: personnel. Personnel for administration, technology and research. The production of suitable candidates for the many and varied jobs is the task of the schools and universities. In these days it is one beset with difficulties, and it may well be that some years must elapse before suitable staff for some of the research posts, for example, in biology, can be produced. But the task lies clearly before us. The sooner we begin, the better for the welfare of the British Colonies.

Science, Poetry and Religion

THREE lectures delivered by Mr. Geoffrey Hoyland at Woodbrooke Summer School in 1944 have now been printed as a challenging and picturesquely written booklet entitled "The Tyranny of Mathematics" (S C M. Press, Ltd., 56 Bloomsbury Street, London, W.C.1 Pp. 52 1*s*. 6*d*. net). Mr. Hoyland's theme is the age-old dichotomy between the emotional and the rational approach to human problems; but his treatment is fresh, partly owing to his vivid style, and partly because it is unusual to find a religious apologist with a good knowledge of science and mathematics. It is not possible here even to summarize his arguments and exhortations. His conclusion, briefly, is that since the Renaissance, and particularly since Newton and Leibniz added the weapon of the calculus to the armoury of the man of science, we have worshipped at the analytical shrine of mathematics, to the exclusion of the true gods of poetry and religion, which, with science as their handmaid, can alone reveal to us the whole truth about the universe. "If our sick world is to be saved the lover and the poet must take control."

Few men of science will go the whole way with Mr. Hoyland, preferring to believe that a constantly adjusted partnership between the emotional and rational elements in life, rather than the supremacy of either over the other, is the most fruitful treatment of the dichotomy (and indeed the only one that would justify the use of the word 'symbiosis' in the subtitle); but many will be stimulated by this keen analysis of the problems involved, and enjoy the colourful language in which it is couched.

Cultivation of Rhubarb

RHUBARB is one of the oldest cultivated plants, for its history in China, its native home, dates back to almost 3000 B.C. At first it was grown solely for the medicinal properties of its roots and was introduced into England from Siberia on that account some three hundred years ago. Later, interest developed in the edible properties of the leaf stalks, but it was not until the nineteenth century that plantings of rhubarb for culinary purposes became widespread. The literature on rhubarb cultivation is scanty, so the illustrated bulletin, compiled by H. V. Taylor and E. E. Skillman, recently issued by the Ministry of Agriculture (No. 113. H.M. Stationery Office. 9*d*.) should prove a great asset to growers. The advice given relates generally to normal peacetime practice. Only a limited number of varieties are grown for commercial purposes; each is described in some detail and attention directed to the fact that all may be seen growing in the gardens of the Royal Horticultural Society at Wisley. The chief area of production is the West Riding of Yorkshire, though in Essex, Lancashire and Cheshire quite a considerable acreage is devoted to the crop. The high rainfall, acid soil and the capacity of the plant to withstand smoke pollution contribute to the success of the crop in the Leeds district; in fact the contaminated atmosphere is an asset for forcing purposes, as it induces premature leaf shedding and early dormancy. The cultivation of both forced and natural rhubarb are described at some length and a section devoted to grading, packing and marketing. As regards diseases, that termed 'crown rot' appears to cause most trouble. Eelworm infection is now thought to be largely responsible for this, though it is not yet clear whether there are not also other factors which contribute to this condition.

Plea for a Museum for Croydon

DR. H W. DICKINSON's presidential address this year to the Croydon Natural History and Science Society discussed the proposal for a museum for the district. Croydon is the largest borough in Great Britain without an adequate museum service, and he stated that the Society is now urging the proposal upon the local authority "as one of the particular objects to be carried into effect in the post-war municipal reconstruction scheme". If the museum materializes, he stressed the importance of a localized policy, and in this connexion suggested that a plan already exists in the form of the Society's Regional Survey of the district. Alluding to museum functions, he placed 'research' before 'visual education', but in view of the present-day urgent need for all forms of education, the smaller regional museums might usefully reverse this order. Dr. Dickinson justifiably deprecated the use of old dwelling-houses for museum purposes, for these do not provide the offices and facilities required for the execution of a useful and progressive service. Referring to the reluctance of municipalities "to spend money on buildings even if they own valuable collections", he reminded the audience that the Nuffield Trust, and the Carnegie United Kingdom Trust, could be approached for financial help. Clearly, Dr. Dickinson has closely studied Markham's report on "The Museums and Art Galleries of the British Isles" (1938), and all authorities undertaking the establishment or reorganization of regional museums in the future could profitably follow his example.

The Cinema

MR. LINDGREN's pamphlet "The Cinema" (English Universities Press, Ltd. 4*d*. net) well maintains the standard set in this Handbook for Discussion Groups series, and should serve as a useful basis for discussion of various aspects of the cinema, including the Report of the Board of Trade Committee on Tendencies to Monopoly in the Cinematograph Film Industry, of which little has been heard since its publication. This particular aspect is indirectly touched by one of the subjects listed for discussion, but in the brief compass of nineteen pages Mr. Lindgren contrives to supply a good deal of background and to indicate most of the broader issues involved, such as the possibilities of the cinema in scientific research, education, the recording of history, the promotion of international understanding and the field of public information. He touches succinctly on the general problems of the entertainment value of the cinema, its influence and the question of censorship, where in two brief paragraphs he brings out the essential weaknesses and dangers inherent in censorship, and incidentally supplies adequate justification for the attempt to stimulate further discussion

of the whole problem. There is an eminently practical note in the whole pamphlet, and if a word of criticism is called for, it is that the bibliography, even within the limits set, might have been improved.

The Cooper Union: Annual Report

THE report of the Director of the Cooper Union, of New York, for the year ending June 30, 1944, covering the eighty-fifth year of the Institution, indicates that, although in some respects the disturbance of education in the United States under the impact of war has been less profound than in Great Britain, the problems of demobilization and of re-training are being faced along similar lines. There is an interesting parallel between educational thought, as portrayed in this report, in the two countries. Stress is laid upon the necessity of finding a strong and socially satisfying ethical foundation for modern education, on the limitations of the scientific method, and on the importance of no longer confining instruction and discussion in the human and spiritual values to the level of higher education and the liberal arts. The humanities and the social sciences should be brought into the curriculum of the high school, vocational school, junior college, technical institute and engineering school. The Department of Humanities of the Union has been successfully experimenting since 1939 with the integration of social and humanistic studies with the curricula of the schools of engineering and art, and is now offering a sequence of studies which, taken as a whole, should give a perspective of the history of Western culture and an appreciation of their roles as citizens and as individuals.

The report recognizes that the professional world of engineering and art properly demands a breadth and depth of preparation and a sophistication which cannot be gained by conventional class-room routine. The Cooper Union has been able to keep the nucleus of the teaching staff of its School of Engineering reasonably close to normal in the war period, and resumption of full teaching loads after the War can therefore be undertaken with speed and efficiency and with only minor additions to the staff. Policies to be followed with regard to the re-training of the demobilized and their integration into academic and social life are indicated, and a sub-committee of the Engineering Faculty has set itself the task of determining those qualities and attributes which should characterize the products of the four engineering curricula. Reference is also made to the work of the Student Health Service in educating the student in the use of the facilities already existing in the surrounding community, and of the Division of Social Philosophy, which completed its first decade during the year, in the field of adult education.

Museums and Adult Education

AN editorial article in the *Australian Museum Magazine* (June–August, 1944) directs attention to the contribution which museums have already made towards adult education. At the same time, it points out that there still remains the necessity for far greater extensions of the museums' services in this direction. It is suggested, for example, that museums should be available to the public out of ordinary working hours; that there should be better accommodation for study; and that there should be an increase of suitably qualified staff to guide and assist students.

Society of Public Analysts and Other Analytical Chemists

THE annual general meeting of the Society of Public Analysts and Other Analytical Chemists, held on March 9, marked the seventieth anniversary of the Society. In the past year the membership of the Society increased by 117 to 1,197, and the circulation of the Society's journal, the *Analyst*, in spite of paper restriction, increased. In pursuance of the policy decided upon a year ago, the Society recently formed, within the framework of its constitution, two Groups concerned with particular branches of analysis, namely, the Microchemistry Group (chairman, Prof. H. V. A. Briscoe; hon. secretary, Mr. R. Belcher; present membership, 143) and the Physical Methods Group (chairman, Mr. R. C. Chirnside; hon. secretary, Dr. F. Wokes; present membership, 115). These Groups will hold meetings from time to time in London and elsewhere. The proceedings terminated with the presidential address of the retiring president, Mr. S. Ernest Melling, who, after reviewing some of the outstanding events of the past year in the Society's affairs, made some observations on the subject of water and water supplies. Dr. G. W. Monier-Williams was elected president for the present year.

Science Masters' Association: Annual Meeting

THE annual meeting of the Science Masters' Association will be held during April 9–11 at the City of London School. The president, Mr. C. L. Bryant, will speak on "The Impact of Science on Common Thought". The proceedings will include lectures by Dr. J. McG. Bruckshaw on "Physics and Economic Geology", Mr. C. Bibby on "Health Education through School Biology"; "Penicillin", by Sir Alexander Fleming; "Scope and Limitations of the Science Teaching Film", by Mr. A. Elton (at the Ministry of Information Theatre); "The Electron Microscope", by Mr. F. W. Cuckow; "Chemistry of Plastics", by Mr. R. Maitland; and a discussion on "The Role of Science in the Future Educational System". There will also be the usual exhibitions. The third lecture on the Science and Citizenship Foundation will be delivered by Mr. J. G. Crowther, who will speak on "The Social Relations of Science", this lecture is open to the public, and tickets for visitors can be obtained from Mr W. Ashhurst, Epsom College, Surrey.

Announcements

THE Bristol Aeroplane Company has given £60,000 to the University of Bristol for the establishment of a Sir George White chair of aeronautical engineering, in memory of the founder of the Company.

THE Biochemical Society and the Nutrition Society have arranged a joint whole-day conference on "The Vitamin B-Complex", to be held on April 28, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Details of the programme will be published later.

PROF. JAMES MACKINTOSH, dean of the London School of Hygiene and Tropical Medicine, is visiting Sweden to lecture for the British Council on aspects of social medicine and health education in Britain. He will probably also visit Finland. Prof. Mackintosh hopes to obtain in Sweden information for inclusion in a report on housing which he is preparing for the British Government.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Presentation of Scientific Data

WORKERS in certain branches of science have to carry in their heads many numerical results and constants, and to read and abstract a vast literature. This becomes even more arduous for those on the borderline between the exact and the descriptive sciences. The difficulties are greatly increased by the less rigorous presentation of borderline results, and by the less stringent editing of journals dealing with a variety of subjects. In chemistry and in physics the symbols and quantities are standardized, but in the applications little regard may be paid to recognized usages. A report drawn up by the Chemical, Faraday and Physical Societies in 1937 listed symbols for thermodynamical and physico-chemical quantities. These were accepted by the Royal Society in 1939. There are, however, many quantities not included in the list. For these, reference to the International Critical Tables or to the Smithsonian Tables is helpful. One major difficulty arises from the fact that the Greek letters and diverse founts of type are lacking on ordinary typewriting machines.

For numerical results it is suggested that, if possible, indices should be avoided, and when used they should refer to the basic unit. Though one may write 17 cm., it is preferable to avoid 17×10^{-4} cm. and to write 17×10^{-6} m., or better, 17 μ. This would be an aid to memory.

It would be a convenient convention if droplet sizes were given as diameters, rendering comparable, for example, the length of a bacillus and the diameter of a coccus with spray droplets. But at present those who measure droplets give diameters and those who carry out mathematical investigations give radii.

It is very confusing when quantities in the same analysis are given in different units. Workers in nutrition are offenders in this. For lack of better, they have to give certain quantities as I.U. (international units), but there is no defence for giving in consecutive lines of a table a vitamin as 19 μ gm./gm. and iron as 1·9 mgm./100 gm., whereas in fact the two quantities are identical. It would appear simpler to give both results in parts per million. Why do they darken understanding by reporting such quantities as per ounce of, say, bread? Surely micrograms are meaningless to workers in ounces, but anyone can understand percentages, parts per thousand and per million. Why write 10^{-8} oz.? It sounds ridiculously small and indefinite, but is actually slightly less than 0·3 μ gm. One may be surprised at detecting a substance "even in a concentration of $1 \times 10^{-10} \gamma$ per μ^3", but the feat is more credible when bluntly put as 0·1 gm. per litre.

It is somewhat of a shock to find depths of corrosion pits given in thousandths of an inch (mils) and the thickness of the overlying paint in microns, but to give the application of paint in square feet per gallon (Imperial or U.S.A.) is convenient and logical, with just this drawback, that it renders the determination of film thickness—simple in the metric system—quite complicated. Also one wonders why anyone should be allowed to report permeability "as milligrams of water per day per square centimetre of film area per mil of film thickness", or a liquid for destroying insects in cubic centimetres per 37 cubic feet of air, instead of using the factor 2360 to convert to the same unit of volume and reporting as parts in 87,000, or per 100,000. All the cases instanced have been met with recently. Furthermore, why do physiologists speak of the tension of oxygen, when they mean the pressure—and why, when a paper went to the Chemical Society giving the boiling point of a pure liquid as so many degrees at so many millibars pressure, was it sent back for conversion to millimetres of mercury, though the Meteorological Office publishes the atmospheric pressure in millibars? Could we not be a little more consistent—and spare our memories unnecessary figures? Could we not in technical reports use the metric system universally and translate such quantities as have workshop application into the British system—where necessary? At present there is often a medley of both systems with a vast waste of time in conversion from one unit to another. In measuring light we have even got to the mile-candle. Before autumn one may find candles per acre After the War, Britain will be poor, so why should we handicap our scientific and technical development by carrying an antiquated system of measurement into new fields? But for those who have to convert, the British Standards Institution Publication 350 (1944) Conversion Factors and Tables is useful.

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Feb. 12.

Sublimation in a Wilson Chamber

As a result of some experiments on the deposition of water vapour at low temperatures, it was found that the liquid phase can frequently exist much further below the freezing-point than was expected. For example, droplets of super-cooled water can be obtained at − 50° C. without difficulty. It appeared also that the number of nuclei in atmospheric air on which water vapour could form ice crystals without the previous formation of droplets was small, and they appear to be active only below about − 40° C. Arrangements were therefore made to repeat Prof. C. T. R. Wilson's classical experiments below the freezing-point, both in thoroughly clean air and in ordinary atmospheric air. The following results were obtained:

Air thoroughly cleaned by repeated expansions. (1) Provided that the lowest temperature after expansion (that is, the temperature when expansion is finished and condensation just starts) does not fall below − 35·0° C., only liquid droplets are formed, however big is the expansion ratio.

(2) If the lowest temperature after expansion falls to − 35·1° C. (± 0·1°) a few ice crystals are formed among a much larger number of droplets. As the minimum temperature falls further below − 35° C., more ice crystals and fewer droplets appear, so that at lower temperatures a fog of ice particles is formed. Whether or not the solid phase appears depends only on the minimum temperature and not at all on the supersaturation.

(3) Provided that the lowest temperature after expansion falls below − 35·0° C., ice crystals are formed although the expansion is below the normal critical ratio.

(4) When the lowest temperature after expansion falls below about $-80°$ C., the number of particles formed decreases and a few of them change in appearance from transparent ice crystals to much larger grains of soft hail. At about $-100°$ C. only a few such grains fall down after expansion. Below about $-120°$ C. no particles are formed. The result does not depend on the expansion ratio, provided it is big enough to make the products visible.

(5) If the air be ionized by X-rays before the expansion, the density of the ice cloud formed is very greatly increased, but the limiting temperatures are not altered.

Ordinary atmospheric air. (1) The limiting temperature of $-35 \cdot 0°$ C. found for clean air becomes $-27°$ C., and varies by $\pm 0 \cdot 5°$ C. from one experiment to another. With air artificially contaminated with tobacco smoke the limiting temperature for the appearance of ice was as high as $-23°$ C.

(2) At the lower temperatures ($-80°$ to $-120°$ C.) the same decrease in the number of particles and the same changes in their appearance occur as in thoroughly clean air.

During the course of experiments, the expansion chamber was surrounded by a cooling bath of different temperatures, all below freezing point. A certain test to indicate the presence of the minutest amount of ice was to have *supercooled* water in the bottom of the expansion chamber. If any ice appeared in the chamber, it could not escape detection It could not melt because all the surroundings were below freezing point. Within a few seconds, any ice particles which may be formed would seed the super-cooled water either by falling to the bottom or by contact with the film of super-cooled water coating the walls of the chamber. Then the water would freeze.

Some preliminary investigation of the properties of super-cooled water made it possible to use this indicator for initial temperatures of the chamber between 0° C. and $-10°$ C. Samples of a few cubic centimetres of water which can be easily super-cooled were prepared by distillation (without boiling) and then boiling the sample for a few hours. Each sample has its own 'freezing point' which it keeps within $0 \cdot 1°$ C. for, at least, a few months. The pressure, up to 100 atmospheres, does not affect the 'freezing point'. Addition of dust raises the 'freezing point'; but crystalline dust is not more active in this respect than amorphous dust. For initial temperatures below $-10°$ C. a long chamber was used. In such cases the ice particles which are formed high in the chamber grow sufficiently when falling to be observed in the beam of an arc lamp illuminating the bottom of the chamber.

It appears that ice particles formed in thoroughly clean air are formed by sublimation, and that sublimation phenomena due to adiabatic cooling differ essentially from phenomena of condensation since: (*a*) the formation of ice particles seems to depend only on the minimum temperature reached after expansion; (*b*) even in thoroughly clean air they are formed at supersaturations which are far smaller than those necessary to form water droplets. These results would seem to have interesting applications to the formation of clouds in the higher atmosphere.

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Explanation of the Joshi Effect

THE interesting experiments of Joshi and co-workers, on what they call the new light effect, relate to the decrease of current flowing in the high-voltage exciting circuit of a Siemen's ozonizer, when radiations fall on the chlorine gas contained within the ozonizer. Alternating voltages of the order of 10 kV. are applied between the inside and outside walls of the ozonizer and the current is measured, its order of magnitude being about 50 microamperes. The experimental arrangement and the description of the effect are given in recent papers by Deo[1] and Joshi[2].

An explanation of this effect seems to be possible from the quantum-mechanical dispersion formula of Kramers, namely:

$$n^2 - 1 = 8\pi B \sum_{l,l'} \frac{\nu(l',l)\,|\,p_0{}^E(l',l)\,|^2}{h[\nu(l',l)^2 - \nu_0{}^2]}\, e^{-W_l^0/kT},$$

where $B = \dfrac{N}{\sum\limits_l e^{-W_l^0/kT}}$, n is the refractive index of the gas for the incident light, and ν_0 is the frequency of the atom or molecule corresponding to a transition from an energy-level $E\,(l)$ of quantum number l to the level $E(l')$ of quantum number l'.

$$\nu = \frac{E(l') - E(l)}{h}.$$

ν is negative if transition takes place from an excited level to a normal level. $p_0{}^E$ are the unperturbed matrix elements of the components of the electric vector E of the primary beam.

The formula shows that in an excited gas, the refractive index should be less than that for the normal unexcited gas, due to the negative terms in the formula for the excited states. This expectation was experimentally established by Ladenburgh[3] in neon. The equation applies to our case if we put ($n^2 = k$) the dielectric constant and ν_0 is the frequency of the electrical circuit, say, 50 cycles/sec. Hence when radiations fall on the chlorine gas, exciting it to higher vibrational and electronic states, the dielectric constant decreases and so does the dielectric current in the electrical circuit, which is essentially a condenser circuit, the plates of the condenser being the two electrodes of the ozonizer.

That our interpretation is not far from truth can be seen from the following considerations.

1. As the current is only of the order of 50 microamperes, for voltages of the order of 10kV., it shows that it is mostly a dielectric current and not the ordinary ohmic conduction current. For a discharge current the magnitude would be of the order of one milliampere[4]. As a matter of fact, Joshi says in one of his papers that when experimental conditions were such as to get a faint glow in the gas, the light effect decreased. This was due to the conduction part of the current having been increased, with the consequent decrease of the change of dielectric current with radiation, as percentage of the total current.

2. The effect is a maximum in white and violet light compared to that for lower frequencies, whereas chlorine has its maximum absorption in the former. This corresponds to increase of magnitude and the number of the negative dispersion terms. Both these effects make the relative change of current bigger numerically.

3. The maximum of the effect occurs, on the whole, in regions of lower voltages, because the lower the

voltage the more is the current of dielectric or displacement nature.

4. The maximum of the effect occurs at some range of pressures, neither too high (atmospheric) nor too low. At higher pressures, though the number of molecules is higher, the life and hence the relative number of the excited states will be lower on account of greater loss by collisions. Again, with decrease of pressure, the magnitude of the discharge current would increase, making $\Delta i/i$ numerically small. A compromise of all these factors leads to an optimum pressure (of the order of 50 cm. mercury) for particular experimental conditions.

An indirect experimental confirmation of our interpretation is the fact that the dielectric constant of ionized gases is less than unity. An excited molecule and an ionized molecule are different stages in the same direction. There may be other minor points associated with the effect, having different causes, for example, the influence of walls of the ozonizer on $\Delta i/i$, etc , but for the main fact of decrease of current with irradiation the effect of negative dispersion terms seems to be the right cause.

A possible weakness in our interpretation is that the intensity of the excited states is usually regarded as small as compared to the normal state.

Fuller details will be published later on.

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Jan. 15.

[1] Deo, P. G., *Ind J. Phys*, **18**, 84 (1944)
[2] Joshi, *Nature*, **154**, 147 (1944).
[3] Ladenburgh, *Rev Mod Phys*, **5**, 243 (1933).
[4] Glockler and Lind, "Electrochemistry of Gases and other Dielectrics" (John Wiley and Sons)

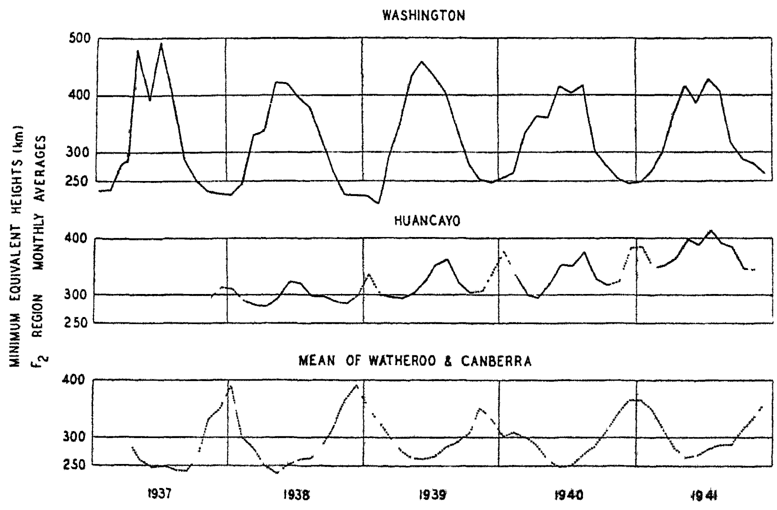
'Anomalous' Behaviour of the F_2 Region of the Ionosphere

IT has been known for some years that the seasonal and diurnal variations, and the geographical distribution of the maximum electron density N in the F_2 layer, the main observable region of the ionosphere, are anomalous in that they do not conform to the simple Chapman theory of ionization production, according to which N should be proportional to $\cos \chi^{1/2}$, where χ is the zenith distance of the sun. For example, in temperate and high latitudes in the northern hemisphere, the noon values of N show a minimum in mid-summer and a maximum in mid-winter, a variation which is exactly out of phase with theory; while in the southern hemisphere in temperate latitudes noon N exhibits maxima near the equinoxes and minima in mid-summer and mid-winter.

Two theories usually are jointly invoked to explain these and other similar anomalies. According to the first, the low values of N in mid-summer are due to a great expansion of the upper atmosphere by solar heating. On the Chapman theory, N is proportional to $T^{-1/2}$, so that such heating, if great enough, might explain the lowering of noon N in mid-summer. This view appears to be supported by the fact that h (max.), the height at which N is found, is some 150 km. greater in summer than in winter. The second theory explains the different type of variation in the northern and southern hemisphere as due to a superposed annual variation of ionization, of unknown origin, which has a maximum throughout the world in December–January and a minimum in June–July. Simple calculation shows that the expansion theory demands a summer value for T of the order ten times greater than the winter value, which is highly improbable on any reasonable theory of radiative equilibrium in the ionosphere, so that it seems desirable to explore other possible explanations of F_2 region anomalies. Evidence in support of an alternative theory is supplied by the data shown in the accompanying graph, which compares the monthly mean minimum equivalent heights h' for north temperate, south temperate and equatorial locations for the period 1937–41. The locations are, respectively, Washington, D.C., the mean of Watheroo and Canberra (Australia) and Huancayo (Peru). The data used were taken from that published regularly in *Terrestrial Magnetism and Atmospheric Electricity* during these years, together with the unpublished records taken at the Commonwealth Solar Observatory, Canberra. The Huancayo graph is drawn as a dotted line when the sun is to the south.

It will be seen from the graphs that the height variations in the northern and southern hemisphere are out of phase, showing a true seasonal variation, with maxima in mid-summer, as the 'heating' theory would predict. On the other hand, it is seen that h' at Huancayo does *not* show maxima when the sun is overhead (that is, in February and October), in disagreement with this theory. Inspection shows, however, that the Huancayo graph parallels that of Washington when the sun is north of Huancayo and parallels that for Australia when it is in the south. (The more complex graphs for N at the same stations, which are not reproduced here, show the same phenomenon.) This behaviour, which is similar to that of the diurnal variation of the magnetic declination at Huancayo, suggests strongly that the variations of h' and N are controlled, as are the magnetic variations, by large-scale tidal movements in the upper air.

Evidence for the existence of such a tide at these levels is presented in a separate communication. The



different seasonal behaviour of N in the two hemispheres is believed to be due to a difference in the seasonal variation of the phase of the tides in the two hemispheres.

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Magnetic Properties of some Paramagnetic Crystals at Low Temperatures

MEASUREMENTS have been made on the principal magnetic susceptibilities of single crystals of a large number of paramagnetic salts of the iron group, from room temperature down to about 80° K. A detailed discussion of the results on the basis of the crystalline field theory will shortly be published elsewhere. According to this theory, the deviations from the simple behaviour to be expected of the free ions are attributed to the Stark splitting of the energy-levels of the paramagnetic ion under the influence of the strong and generally asymmetric electric field that occurs in the neighbourhood of the paramagnetic ions in these crystals, due to the negatively charged atoms that surround these ions. The following are some of the main results obtained.

In manganous and ferric salts in which the paramagnetic ion is in the S-state, the anisotropies are negligibly small, and the temperature variation of the susceptibility almost exactly follows the Curie law $\chi = C/T$.

In chromic salts also this is so, even though the Cr^{+++} ion is not in the S-state. This is due to the fact that the lowest level in the Stark pattern of Cr^{+++} is a singlet, and it is widely separated from the upper levels; the singlet level, however, has a $(2s + 1)$-fold spin-degeneracy.

The nickel salts are very similar to the chromic salts in their magnetic behaviour, except that the spin-orbit coupling in Ni^{++} is much greater than in Cr^{+++}, and this conduces to a much larger deviation from the S-state behaviour than in Cr^{+++}; in other words, it leads to an appreciable magnetic anisotropy and deviation from the Curie law. These deviations are utilized to calculate the crystal field constants, and it is found that not only the cubic part of the field which is predominant, but even the rhombic part which is small, is nearly the same in most of the nickel salts, and they are practically independent of temperature.

In both Co^{++} and Fe^{++} salts, owing to the ground-level being a triplet, the magnetic properties are more sensitive to the rhombic part of the field than in the nickel salts. An estimate has been made of the rhombic part of the field.

The copper salts, as judged by their magnetic properties, fall into three distinct classes. In the first class all the principal susceptibilities follow the Curie law, but with different Curie constants; that is, the effective moments are different for different directions, but all of them are practically independent of temperature. To this class belong the Tutton salts. In the second class the principal moments are nearly the same as before, but they all decrease with the lowering of temperature, slowly at first and rapidly at later stages. The double chloride of copper and ammonium is a typical example of this class. To the third class belongs cupric acetate monohydrate, in which the principal moments are all very low even at room temperature and decrease rapidly as the temperature is lowered. The three classes correspond to the non-cubic part of the crystalline field, being very different, lowest in the first class and highest in the third.

The influence of covalent binding on the strength of the electric field, and ultimately on the breaking of the Russell-Saunders coupling not only between the spin and orbital moments, but also between the spins of the different electrons of the ion, and its effect on the magnetic properties of the ion, have been discussed.

Though in the majority of the crystals the magnetic axes do not change their directions in the range of temperatures studied, the change is appreciable in some crystals, the largest change observed being 7°.

There is an axis of magnetic symmetry in nickel and ferrous salts, even though the crystal structure does not lead to it.

My thanks are due to Prof. K. S. Krishnan for his interest in this work, and to the Indian Association for the Cultivation of Science, Calcutta, for facilities for carrying out the experiments.

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Theory of Viscosity of Concentrated Suspensions

FOR infinitely diluted suspensions of rigid spheres, Einstein[1] derived on a rigorously theoretical basis the formula

$$\eta = \eta_0 (1 + kc), \quad . \quad . \quad . \quad (1)$$

where η is the viscosity of the suspension, η_0 is the viscosity of the pure solvent, c is the concentration by volume and $k = 2{\cdot}5$ is a constant. It has been shown that (1) is also valid for non-spherical particles, the factor k being a function of their shape, rigidity and Brownian movement. For elongated rigid particles, $k > 2{\cdot}5$.

If it is assumed that the suspension behaves hydrodynamically with respect to an additional particle as a homogeneous medium, it is possible to derive a theoretical viscosity formula for higher concentrations. Let us add a particle of a volume dV to a suspension of viscosity η, containing already a volume V of similar particles in a volume A of the pure liquid. Then the increase of the viscosity should be

$$\eta + d\eta = \eta\left(1 + k\frac{dV}{A + V}\right), \quad . \quad . \quad . \quad (2)$$

or after a slight rearrangement

$$\frac{d\eta}{\eta} = k\frac{dV}{A + V}, \quad . \quad . \quad . \quad (3)$$

which can be easily integrated, giving

$$\eta = \eta_0 (1 + V/A)^k = \eta_0 (1 - c)^{-k} \quad . \quad (4)$$

If $c = 0$, $\eta = \eta_0$, so that the integration constant η_0 is the viscosity of the pure liquid.

The assumption of hydrodynamical homogeneity of the suspension holds only if the particles are sufficiently far apart, so that their mutual interactions other than a general increase of viscosity are neglig-

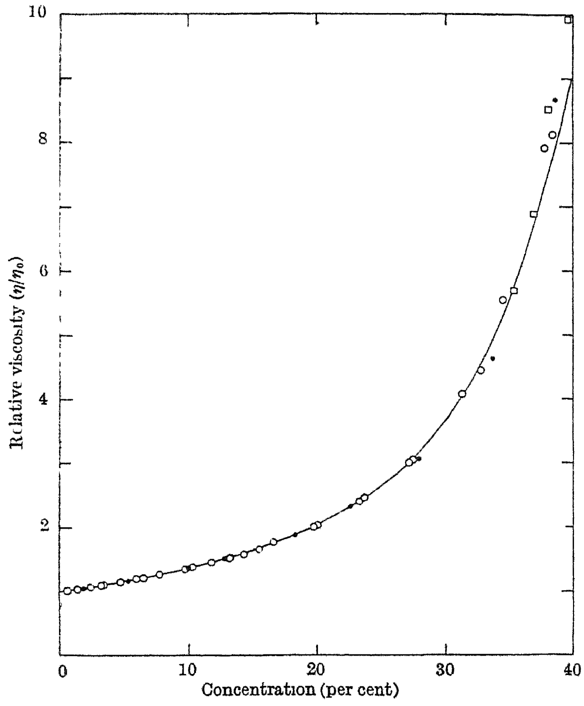
ible However, under the shearing motion of the liquid the particles move relative to each other and collisions occur. These do not resemble collisions in a gas, the particles rolling round each other, until they reach such positions that a disengagement through further shear takes place.

It can be shown for suspensions of rigid spheres that each sphere is in collision for an average fraction of time proportional to the concentration c. During this time the colliding pair increases the viscosity more than a separated pair, due to a combination of several effects. The most important effect is caused by a certain volume of liquid being immobilized around the point of contact. This volume is proportional to the volume of the spheres. The total immobilized volume qVc, where q is a proportionality constant, should be thus subtracted from A and added to V in equation (4). Whence

$$\eta = \eta_0[1 + (V + qVc)/(A - qVc)]^k = \eta_0 (1 - c - qc^2)^{-k}. \qquad (5)$$

The constant q was calculated by an approximate method to be not far from unity for rigid spheres, and it is expected to be much less, if the spheres are soft, as there will be less liquid immobilized around the point of contact. The shape factor k should also change slightly with concentration, as two colliding spheres behave as one non-spherical particle; but this effect is negligible compared with the effect of the immobilized liquid.

As there are no accurate viscosity data available for concentrated suspensions of rigid spheres, measurements of Eirich, Bunzl and Margaretha[2] extending only up to about 20 per cent, measurements of suspensions of glass spheres were made to test the formula (5). The glass spheres of 0·013 cm. diameter were kindly loaned by Dr. F. Eirich, being the same as those in his investigations. The spheres were suspended in a saturated solution of zinc iodide in water and glycerine which has the same density as glass and a high viscosity of 80 centipoises at 20° C.; this made corrections for inertia effects of the spheres unnecessary.



Relative viscosity of suspensions of glass spheres as a function of concentration by volume.
Ostwald viscometer measurements, capillary diameter 0 23 cm., ●; capillary diameter 0 38 cm., ○; Couette viscometer measurements, □. Theoretical curve calculated from the formula (5) with $k = 2{\cdot}5$, $q = 1{\cdot}16$, full line.

Measurements were made in two Ostwald viscometers, having diameters of the capillary 0·23 cm. and 0 38 cm., and in a Couette apparatus with diameter of the inside cylinder 1·264 cm., of the outside cylinder 3·6 cm. The uncorrected measurements from different viscometers were in disagreement with each other, but after being corrected for the wall effects they agreed surprisingly well, as can be seen from the accompanying graph, where the corrected results from different instruments are plotted against concentration. The full curve represents formula (5) with values of $k = 2{\cdot}5$ and $q = 1\ 16$, which are the values fitting best the measurements. The agreement of the measurements with the formula (5) is well within the experimental error up to a concentration of 37 per cent.

Above this concentration, suspensions subjected to shear are no longer isotropic and exhibit different viscosities in different directions; the rate of shear ceases to be proportional to the shearing stress and depends on the previous history of shears.

I wish to express my thanks to Dr. F. Eirich for the loan of the spheres. Detailed results will be reported elsewhere.

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Fluidity and Molecular Structure

It was pointed out by Porter[1] that, for mercury and water, the logarithm of the viscosity is a linear function of the logarithm of the vapour pressure. I propose a modified relationship introducing the critical pressure p_c, namely,

$$\log \varphi = a \log p/p_c + d,$$

where φ is the fluidity of a liquid at the vapour pressure p, a and d are constants.

Putting $p = p_c$, then $d = \log \varphi_c$, and we can write:

$$\log \varphi/\varphi_c = a \log p/p_c \quad \text{or} \quad \varphi/\varphi_c = (p/p_c)^a \quad . \quad . \quad . \quad (1)$$

It has been found that, with the exception of associated substances, and apparently a small number of liquids possessing highly symmetrical molecules, a does not differ greatly from the mean value of 0·24 for all pure compounds examined. Equation (1) expresses an interesting extension of the theory of corresponding states, for it implies that, at the same reduced pressure, non-associated liquids have nearly the same reduced fluidities. Furthermore, as a rough approximation, such liquids possess the same value of $d = \log \varphi_c$, and so the fluidity or viscosity of a substance depends primarily on its 'distance' from the critical state.

In the simple Porter equation, $\log \varphi = a \log p + b$, b is the value of $\log \varphi$ at some arbitrary unit pressure; for example, expressing p in standard atmosphere

units, b becomes $\log \varphi_B$, the logarithm of the fluidity at the boiling point under 760 mm of mercury pressure.

For substances examined having a approximately 0·24, it has been found that the function $M \log \varphi_B$, where M is the molecular weight, can be evaluated from a list of atomic and structural constants, and the fluidity of a given non-associated liquid at its boiling point be calculated with an average error of 3 per cent.

Work on these lines is now in progress together with an examination of the above relationships as applied to liquid solutions. Full details will be published as soon as possible.

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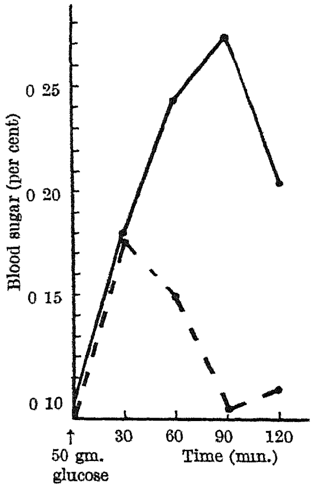
Effect of Electrically Induced Convulsions on the Sugar Tolerance of Psychotic Patients

IN this Hospital, investigations are being made on the sugar tolerance curves of a number of psychotic patients. Abnormal curves in such patients have been found by workers in the past[1,2].

As progress is comparatively rapid during electric convulsion therapy, it was felt that possible changes in these curves during treatment might be present and this was in fact found to be so. Patients suffering from depressive and manic depressive insanity show the greatest abnormality in their sugar tolerance and also the greatest change in this during treatment. The typical curve before treatment is shown in the accompanying graph. The fasting level is normal or slightly raised, there is a rapid rise to heights well above physiological limits followed by a sharp descent, but not reaching the original level in two hours.

After two to six convulsions, although the mental condition improves, the curves show increasing abnormality. Thus, in most cases the fasting level is raised and the maximum reached in half or one hour is in the region of 0·4 gm. per cent. Gradually, after the mental condition has been normal for many weeks, the curves become normal too.



SUGAR TOLERANCE CURVE
Full line, patients: broken line, average normal.

In all cases of depression the first effects of electric convulsion therapy on the sugar-tolerance curve is to raise both the fasting level and the maximum.

This profound physiological disturbance described above is of great significance since it shows, at least for some mental disorders, a relationship between metabolism and the so-called functional disorders.

This investigation is being continued.

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Œstrogenic Substances showing Anti-tumour Action

CONTRARY to the general impression (due to publications attributing carcinogenic properties to œstrogens when administered to both sexes of different animals; also the œstrogenic activity, although notably weak, of many carcinogens), I have during my researches[1,2] on œstrogens come to believe that these compounds are not carcinogenic, and that they will most probably show at least some curative influence in the case of tumour diseases. I submitted a detailed report on "Œstrogens as Anti-tumour Compounds" to the Ministry of Public Health in Egypt on May 30, 1944. An account of the influence of synthetic œstrogens upon advanced malignant disease was recently published[3].

Owing to the remarkably prolonged action of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene[4,5] when given orally, and its remarkably low toxicity, if any[6], it was proposed to use this substance in the treatment of ovarian tumours and cancer of breast. The following describes its influence in two cases of cancer:

Case 1. A patient fifty-seven years old was operated on for breast cancer, the right mammary gland being removed. Seventeen months later recurrence with metastases in the liver was noted. Within the next eight weeks the patient became much worse, became dumb, the fæces became colourless apparently indicating biliary obstruction, and œdema developed in both legs and in the right arm. On July 3, 1943, a 100-mgm. cachet of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene was given to the patient, and on the following three days, a 250-mgm. cachet was given daily. The œdema completely disappeared within five days from the beginning of the treatment, the fæces resumed the normal colour and the patient spoke once. The patient, however, died on July 10, 1943.

Case 2. A patient aged forty-five suffering from sarcoma ovarialis of a comparatively large size had the abdomen opened in the King's Hospital, Cairo, on July 31, 1943, and the tumour being inoperable, was left untouched. The tumour continued to increase in size, filling the abdomen and pressing against the different abdominal organs. Treatment with αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene began on August 23, 1944, the œstrogen being administered

orally (6–8 gm. monthly, in 200-mgm. cachets, once, twice or thrice daily with intermittent intervals of 2–3 days every 3–5 days). A considerable improvement took place. Dr Hamed Mohamed El Dewany, the private physician of this patient, states · "the patient suffered from sarcoma ovarialis. Surgeons and radiotherapists, who were consulted, considered the case hopeless. With the administration of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene proposed by Dr Wadie Tadros, the tumour softened and decreased in size, and the patient was relieved from pain". The tumour, although at a slower rate, is at present continually regressing.

It is remarkable to note the drop of temperature almost to normal within 3–4 days after the administration of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene to cancer patients with temperature above normal. When tested *in vitro*, however, it was reported[7] that it had no anti-bacterial action.

Robson and Ansari[8] noted that the fate of this substance was, in some respects, very different from that of the œstrogens so far studied. Unlike the natural œstrogens, which are rapidly inactivated (chiefly by the liver), and stilbœstrol, which is rapidly eliminated from the body after absorption, it is stored in the body tissues to an appreciable extent and is eliminated comparatively slowly.

Although the administration of œstrogens in attempting to treat malignant diseases gave in many cases beneficial effects, it is to be noted that in dealing with the problem of these diseases, many factors, apparently interrelated, have to be taken into consideration. Among these may be mentioned the anæmia prior to or after the development of the malignant disease, secondary infections, degree of malignancy and toxæmia due to necrosis of tumour tissues. Moreover, it seems likely that controlled application of both radio- and œstrogenic-therapy may sometimes be desirable rather than the administration of high overdosage of the œstrogen alone, provided that other factors such as anæmia, toxæmia, etc., referred to above, can be dealt with. Prophylactic implantation of œstrogens following surgical and radium castration has been reported[9].

The application of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene in an attempt to treat different types of malignant diseases is in progress in collaboration with different medical investigators, and results will be published when sufficient data are available. In the meantime, I am continuing investigations on the synthesis of more highly active œstrogenic compounds with greater anti-tumour effect.

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Foot Rot (*Phoma* sp.) of Flax

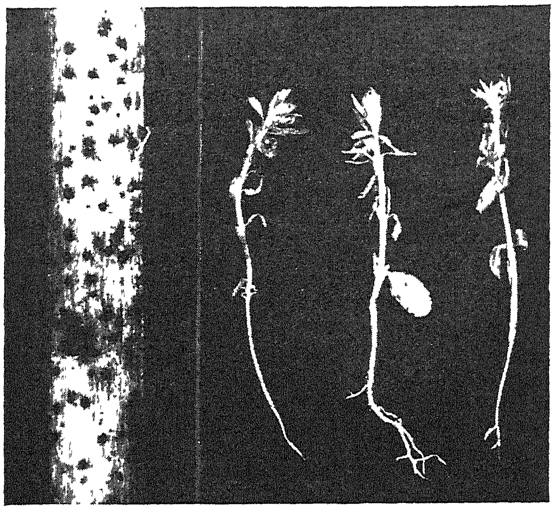
FOOT rot disease of flax caused by a species of *Phoma* was first recorded in Ireland by Pethybridge *et al* [1] in 1921. Since then it has been noted to occur consistently in the Northern Ireland crop although the responsible species of the parasite still awaits identification. A review of the literature indicates that *Phoma* has been reported as attacking the flax crop on the Continent of Europe since the 1890's, and, more recently, in Australia[2], the causal organism being variously referred to as *P. exigua*, *P. herbarum* and *P. linicola*.

Foot rot first becomes readily noticeable during mid-season when odd plants here and there in the crop show a wilted appearance. On pulling affected plants, pycnidia of *Phoma* will normally be found to occur in profusion along the basal portions of the stems (see photo.) The plants die prematurely and turn brown while the remainder of the crop is still green. Although foot rot is the phase usually encountered, the fungus can attack and kill the plants in the seedling stages (see photo.); the nature of the attack and the symptoms produced are largely determined by seasonal growth conditions.

The disease may be found if searched for in almost any season, but, until 1944, it was seldom found attacking more than a few straws in any crop, and it was for this reason that Pethybridge and Lafferty included it in the group of less important flax straw diseases referred to collectively as causing 'dead stalks' in the crop. That the disease may be of a serious nature and of epidemic importance was revealed in 1944 when some crops in Northern Ireland, Scotland and Wales were seriously affected; this epidemic outbreak was quite unexpected and, until then, no such cases had been recorded.

The pathogenicity of *Phoma* towards flax is well known, and has been confirmed by our experiments. Until now, however, it has been generally assumed that the parasite is normally soil-borne and that infection is most likely to occur through the medium of the soil. This may be so, but evidence accumulated during the past few years shows that the parasite may be seed-borne and indicates that the seed may be a more effective means for transmission than the soil. Seed produced in the more northerly and westerly parts of the United Kingdom is much more likely to be contaminated with the parasite than that produced in the south and east. This is due, no doubt, to climatic conditions and to the greater difficulty of harvesting non-weathered crops in the north and west. There is also a tendency towards a building up of seed contamination when seed is successively saved from crops grown in areas liable to favour the incidence of the disease and when a succession of poor seasons is experienced. It has been found possible to use the Ulster method[3] for determining the extent of seed contamination and this has proved most useful in the separation of clean from contaminated seed.

The fact that the parasite may be seed-borne raises the question of the efficacy of seed disinfection in clearing it from a seed sample. Using the same technique as that devised for *Colletotrichum linicola* and *Polyspora Lini*[4], we have carried out a large number of laboratory tests with the following results. 'Nomersan' (10 per cent tetra-methyl-thiuram disulphide), which has proved effective for the control of *C. linicola* and *P. Lini*[5,6], did not give very satisfactory results in the case of *Phoma*; repeated trials indicate it to be about 50 per cent effective when



LEFT, FLAX STEM (× 6) SHOWING PYCNIDIA OF *Phoma* SP, RIGHT, FLAX SEEDLINGS ATTACKED BY *Phoma* SP.

used at the rate of 12 oz. per cwt. of seed. The short wet method of seed treatment using an 8 per cent solution of 'Ceresan U.564' at 0·9 gall. per cwt., although more effective than treatment with 'Nomersan', still did not provide adequate control. Further trials have been made using 'Arasan' (50 per cent tetra-methyl-thiuram disulphide), 'New Improved Ceresan' (5 per cent ethyl-mercury-phosphate), 'Fermate' (ferric dimethyldithiocarbamate) and 'Spergon' (98 per cent tetrachloro-*para*-benzoquinone). Of these materials promising results have been given by 'New Improved Ceresan' and 'Arasan'. Using 'New Improved Ceresan' at the rates of 12 oz. and 9 oz. per cwt. of seed, the contamination of a seed sample was reduced from 32·6 to 2·0 per cent and 5·5 per cent respectively. 'Arasan' used at the same rates reduced contamination to 10·8 per cent and 14·5 per cent. In the case of 'Arasan' it is of interest to note that the duration of the test had to be extended from seven to twelve days as this disinfectant exerts an inhibiting effect upon the fungus. No such effect was noted in the case of 'New Improved Ceresan' which appears to be more directly toxic. Whereas 'New Improved Ceresan' showed generally powerful fungicidal and bactericidal activity, the same selectivity was noted in the case of 'Arasan' as with other disinfectants with tetra-methyl-thiuram disulphide as the active constituent; in the case of bacteria and some fungi these materials have little or no effect.

Although it has not yet been possible to arrange for field trials with these materials, the high degree of correlation obtained between the results from laboratory and field trials in the case of *C. linicola* and *P. Lini*[7] suggest that results obtained in the laboratory should also be closely applicable in the field in the case of *Phoma*. It is proposed to adopt the use of both 'Arasan' and 'New Improved Ceresan' on a commercial scale during 1945. Of all the disinfectants tested for flax, 'New Improved Ceresan' offers the greatest promise for seed-borne diseases generally, its only drawback being its poisonous nature when compared with 'Arasan' and 'Nomersan'.

Tests made with samples of seed treated with 'Arasan' or 'New Improved Ceresan' at the rate of 12 oz. per cwt. have shown that such treatment has no effect upon germination. No adverse effects upon germination have been observed after treated seed has been stored for eight weeks either in small packets in the laboratory or in hundredweight lots subject to ordinary storage conditions. In all cases the moisture content of the seed used was below 10 per cent.

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A Method of Estimating the Activity of Spermatozoa

IN view of the absence of any satisfactory method for the quantitative estimation of the motility of spermatozoa, it is believed that the following method, evolved in relation to work on human semen, may prove of interest.

The semen is diluted with warm phosphate-glucose solution[1] (one in twenty gives a satisfactory dilution for semen containing 70–200 million sperm per c.c.). The dilution is thoroughly mixed by bubbling air through it with a pipette. One drop of fluid is placed on each of two Thoma counting slides. Over one drop is inverted a small straight-sided glass capsule lined with filter paper moistened with 2 per cent osmic acid. The osmic vapour permanently immobilizes all the sperm in about ten seconds. The capsule is removed, and cover slips are placed on both drops, taking the usual precautions to avoid running over. If the capsule is kept upside down on a glass plate, one drop of osmic acid will last about six hours.

The slides are put aside to allow the sperm to settle, that with the motile sperm being placed on a warmed microscope stage. After five minutes this slide is examined and a count made of the immobile, and of the feebly moving but non-progressive sperm in 160 small squares. The two figures thus obtained may be stated as x and y respectively. The actively moving sperm are ignored. A count is then made on the osmicated slide of all the sperm in 160 small squares, giving a figure z. Subtraction of $x + y$ from z gives the number of active sperm in the suspension corresponding to a total number of sperm z, and a volume of fluid contained in 160 small squares.

Sperm which have been cold for an hour or longer do not all become active immediately when mixed with warm diluting fluid, and maximum motility may not be reached until the dilution has been kept at 37° C. for an hour.

When repeated estimations of motility are required during the course of an experiment, it is essential to take two drops for comparison each time, as clumping or disintegration may cause a progressive reduction in the total number of sperm in the suspension.

This work has been assisted by a research grant from the Family Planning Association.

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MEAT IN GREAT BRITAIN

THE British consumer recognizes very clearly that war conditions have brought about marked changes in the kind as well as the quantity of meats we eat. The British farmer realizes the changes that have taken place under war controls in the methods of marketing the meat products of his farm. The former may long for the freer choice of kind, quality and price of pre-war times, the latter may wonder how far the present marketing systems foreshadow post-war schemes. Both are in doubt as to the supplies which may be available, and probably neither completely comprehends the broad complexity of the home supply-distribution situation, as it affects the home-market position. Moreover, meat is, in normal times, a foodstuff in which individual preferences for quality, as well as of purpose and price, are allowed wide play. The pie or the pot, the stew or the roast, an 'r' or no 'r' in the month—while such preferences can be signs of the housewife's whim, or her purse, they can also be factors affecting supply and distribution

At a meeting of the British Society of Animal Production, held on February 21, the meat situation in Great Britain was reviewed from three main aspects, the leading papers being: on supplies, by Major W. H. Warman and Mr. R W. Pomeroy; on carcass quality and grading, by Dr. E. H. Callow; and on the marketing and distribution of home-produced meat and livestock, by Mr. T. J. Shaw.

Before the War, Great Britain consumed, in addition to her own production, about 90–95 per cent of the world's exported surplus of meat. Advances in processing techniques have given us chilled, frozen, boned and canned meats. Whatever the country of origin of the imported meat, its production, processing, grading, transport and distribution were organized towards meeting fairly specific consumer demands, which formed only part of the home-consumption market. In contrast, British home production was all absorbed here in its wide variety of kinds, weights, qualities and prices. Again, owing to, or coincident with, the canalization of the whole industry in exporting countries, the treatment and utilization of edible and inedible offals have become highly developed and contribute to the efficiency and economy of the processing system. In contrast there were, before the War, just over 16½ thousand slaughter-houses, private and municipal, handling roughly 17½ million carcasses which formed the home supply of Great Britain. Further, within Great Britain we have fairly well defined importing and exporting areas; for example, the populous conurbations, as against Scotland and the south-west of England, respectively. So far as stock movements are concerned, there were frequent changes in ownership, not necessarily connected with changes in the condition of the stock; for example, store stock could change hands several times as stores, and partly fattened animals pass from one owner to another without progressing much towards the 'finished' slaughter stage. Also, the question of the effect of movement of fat stock on the quality of the carcass still needs investigation; for the best results and the most efficient supply service, should finished stock be slaughtered in the producing areas or in the consuming areas?

In relation to consumer's preferences the general trends up to 1939 were towards youth rather than to age, to tenderness rather than flavour, and to lighter weights rather than large cuts Geographical variations complicated the situation, thus while the Midlands and the north preferred large pork and bacon carcasses, London and the south favoured pork of about 60–80 lb. weight. Moreover, even with the wide use of feeding-stuffs imported from overseas, there were marked seasonal fluctuations in the kinds of meat produced here: stall-fed winter beef, autumn grass-fed beef, lamb from the arable flocks of the south in spring, hill lambs and ewe mutton later in the year, and older lambs bred on the hills but fattened on root grounds still later, and on into the first months of the year. Also, in spite of these trends we consumed—we had to, though Lancashire liked to—considerable quantities of cow beef, thereby absorbing the high wastage in our milk-producing herds.

War economy has imposed severe changes on this general structure. The emphasis is on quantity—weight rather than quality The exclusion of imported feeding-stuffs has placed reliance on home-grown fodders, and revealed a 10 per cent fluctuation in autumn weights between good grazing seasons and bad. Fat stock pass into control at local collecting centres at which the basis of payment is fixed according to grading schedules Local consumption, apart from supplies originating overseas, is closely related to local production.

The results of these measures of control were soon manifest in all classes of meat, but in one respect the harvest is still to appear—the emphasis on dairy stock which attends the priority given to milk production is judged to lead, with herd wastage still high, to a relative increase in the beasts with inferior capacity to give good beef. Yet nuclei of good beef-breeding types remain, and our presently diminished pig and sheep stocks still contain those types upon which, by appropriate use and from suitable combinations in cross-breeding, the British meat-producing industry could be rebuilt in its multiplicity of kinds and qualities.

If the post-war rehabilitation and form of the meat-producing industry of Britain are to be grossly influenced by the use of imported feeding-stuffs, the questions of available shipping and of available exchange will be prominent. Also, but by no means independent of these, there is the long-term trend for many of those countries which have in the past exported feeding-stuffs to prefer to convert those feeds to carcasses at home, and thus to export, for example, their cereal grains as meat, of higher cash value per unit weight. Behind all, there lie the possible and prospective changes in methods of production and local consumption and demand in the areas from which our meat imports were derived.

This review only touches upon some of the major topics which emerged in the general discussion; it may indicate how the problems are interlaced and the need for much further precise information. Fortunately, there has been a steady accumulation of data which tend to resolve the elusive problems of meat quality and to elucidate the relationships of growth, fattening and food values In this direction, at least, the scientific principles on which the characteristics of the consumers' demands can be interpreted back to the producer are becoming revealed, and the exposition of the results of recent work in this field at the Low Temperature Research Station at Cambridge made a valuable contribution to the proceedings.

It is hoped that a full report will shortly be published by the Society. J. E. Nichols.

A COLTSFOOT PROBLEM

By RICHARD MORSE

SOME time ago, when I was carrying out some investigations concerning the behaviour of plants, I came across the statement, in Sir J. E Smith's "English Flora" (1829), that the flowers of the coltsfoot (*Tussilago farfara*) are "drooping in the bud". The statement surprised me because, although I had been observing the behaviour of this plant fairly closely over a number of years, both in its wild state and under controlled conditions, I had never once seen it produce flower buds that could in any sense be called drooping. As it was inconceivable that the coltsfoot had changed its behaviour since 1829 I could only conclude that the great botanist was in error; and there the matter was allowed to rest.

Recently, however, I have had occasion to inquire into the subject again, and have been amazed at the number of authors who have, in one form or another, repeated Sir J. E. Smith's statement—a statement which I still believe to be wholly untenable.

In Richard Deakin's monumental "Florigraphia Britannica" (1847), for example, the coltsfoot is described as having "the bud drooping, erect when in flower". Yet Deakin was, presumably, a careful worker with an extensive knowledge of British plants, for we are assured in his fourth volume that the entire series of illustrations, numbering well over 1,600, "are accurate facsimiles engraved from original drawings, made by the Author from the Plants themselves, and carefully coloured after nature".

Again, in the third volume of the five which Anne Pratt devoted to "The Flowering Plants and Ferns of Great Britain" (1856), reference is made to "the drooping unexpanded flower-buds" of this plant; in Hooker's famous "Student's Flora" (1884) appear the words "drooping in bud"; in Johns' "Flowers of the Field" (1919) the phrase takes the form of "drooping before expansion"; in Babington's "Manual of British Botany" (1922) the heads are spoken of as being "erect in blossom and seed, drooping before and after flowering"; and in Macgregor Skene's "A Flower Book for the Pocket" (1935) occurs the similar statement that "the head droops in the bud and again after flowering".

The above books, it will be observed, cover the period 1829–1935, so that, during more than a hundred years, students of British botany have been asked to accept, in regard to one of our commonest native plants, a statement which, so far as my experience goes, has no foundation in fact, and yet which, so far as I know, has never been discussed or corrected—save for one brief reference that I myself made to it in a broadcast talk some years ago.

What makes the problem stranger still is the fact that several of the books I have mentioned have passed through more than one edition, without, so far as one can tell, any query being raised as to the correctness of the assertions made. Thus my quotations are taken from the second edition of Smith's "Flora", the third edition of Hooker's, the tenth of Babington's "Manual" (edited by A. J. Wilmott), and the thirty-fourth of Johns' "Flowers of the Field" (revised by G. S. Boulger).

Allusions to the coltsfoot's alleged habit of drooping its flower buds, moreover, are by no means confined to books of the more scientific *flora* type. They have crept also into our agricultural, educational and 'popular' botanical literature.

Thus in the Ministry of Agriculture's "Collected Leaflets on Weeds", second edition, 1923, we are told that "at first the flower heads droop, but when they open out they are erect"; and H. C. Long, in his "Weeds of Arable Land" (1929), uses precisely the same words.

Similarly, Prof. F. Cavers, in his "Life Histories of Common Plants" (1913)—a book intended chiefly for student teachers—tells us that each flower head "at first droops, but later becomes straight"; and in his more advanced work entitled "Botany for Matriculation", revised by L. C. Fox in 1931, those exact words are repeated.

In books of a less scientific character, written chiefly for the general public, the alleged drooping buds of the coltsfoot have been mentioned time and again, for although nutant flower buds are common enough in Nature, this particular story seems to have caught the popular imagination In James Cundall's "Everyday Book of Natural History" (1866), for example, we read that "at first the flower bud is pendulous, and is thus protected from the rain; as soon, however, as the bloom is ready to unfold to the sun, the flower stalk becomes erect".

John J. Ward, in his "Life Histories of Familiar Plants" (1908), is even more explicit. "The coltsfoot," he says, "guards its pollen almost as a bird does its eggs. When at first the flower stem peeps above the soil, its head droops while the stem elongates. Then, suddenly, the head becomes erect and the florets are exposed."

Again, G. Clark Nuttall, in his fascinating seven-volume work entitled "Wild Flowers as they Grow" (1912), tells us that, in February, the coltsfoot's "hard, thick stem with drooping head pushes up through the earth"; while Edward Step, in his "Spring Flowers of the Wild" (1927), says that "until the female florets are ready to open, the stem is bent, so that the head droops".

I must confess that I am much puzzled by the above and other similar references to what I believe to be a wholly fictitious phenomenon. At the time of writing I have no access to floras of a date earlier than Sir J. E. Smith's, so I am unable to say whether the belief in the coltsfoot's drooping flower buds goes back beyond his day or not.

Two possible explanations of the prevalence of the belief occur to me. One is that, after someone's original blunder, author has copied author through all these years without ever referring to the plant itself; and the other is that the closed fruit heads have been mistaken for unopened flower heads. The fruit heads do, of course, droop for a time after fertilization has taken place. They are, however, so markedly different in appearance from the flower buds that it seems almost incredible that even the veriest amateur could mistake one for the other.

But there is also, of course, the further possibility that my own observations of the plant are at fault. On that point, however, I must leave readers to judge for themselves.

Perhaps I should say, in conclusion, that the omission of several well-known floras from the above list must not be taken to mean that they have not been consulted, but simply that I have not yet found one that controverts the statement made by Sir J. E. Smith. There is no reference to the matter, for example, in Withering's "Arrangement of British Plants" (1830), or in Hooker and Arnott's "British Flora" (1850), or in Grindon's "British and Garden

Botany" (1864), or in Bentham's famous "Handbook" (1924), or in Bonnier's "British Flora" (1925) or in any similar work to which I have access. Brimble, in his "Flowers in Britain" (1944), does not query Smith's statement; but, though he refers to the flower heads being "borne at the ends of thick, erect stalks with hairy bracts", he does not state that the flower buds droop. Furthermore, an illustration shows an erect flower bud.

THE BROAD TAPEWORMS OF MAN, CORMORANTS AND GULLS

J. B. DUGUID and E. M. Sheppard (*J. Path. and Bact.*, **56**, 73; 1944. See also *Nature*, **154**, 185; 1944) described their discovery of plerocercoids of a Diphyllobothriid tapeworm in freshwater trout and sticklebacks in a South Wales reservoir and their work on its life-history. M. D. Hickey and J. R. Harris (*Brit. Med. J.*, 310, Sept. 2, 1944) also found Diphyllobothriid plerocercoids in trout in the Dublin area, and a Diphyllobothriid adult tapeworm in sea-gulls and cormorants there (see also M. D. Hickey, *Brit. Med. J.*, 482, Oct. 7, 1944, and K. Unsworth, *ibid.*, 385, Sept. 16, 1944). K. Unsworth (*Ann. Trop. Med. and Parasit.*, **38**, 213; 1944) has now published the results of his work on the life-history of the South Wales species.

Starting with a rat infested by Duguid and Sheppard, Unsworth was able to confirm the results obtained by them. He successfully infested the copepods *Cyclops strenuus* and *Diaptomus gracilis*, which Duguid and Sheppard also used, but found that the former was the best first intermediate host. The nauplius larva of Cyclops readily ate the coracidia, which were fully developed by the time that the later copepod stages were reached. After 16–20 days of development in Cyclops, which Unsworth describes, the Cyclops were fed to sticklebacks, in which plerocercoids were obtained, chiefly in cysts on the serous surface of the stomach, under the peritoneum and under the liver capsule. When these sticklebacks were fed to one pike, which is known to be a second intermediate host of *Diphyllobothrium latum* of man, one plerocercoid was obtained from the pike. When plerocercoids from both the infested sticklebacks and the pike were fed to puppies aged 2–3½ months, the adult tapeworm developed in the puppies, which passed eggs in their fæces. Coracidia from these eggs infested Cyclops. Unsworth makes the interesting and epidemiologically important suggestion that the overwhelming infestation of the trout in so large an expanse of water in South Wales (100 per cent) was due to the fact that the trout ate sticklebacks which had already infested themselves by eating infested copepods. He supports this suggestion by the observation that the commoner fish hosts which harbour plerocercoids of Diphyllobothriid species (for example, perch, pike, wall-eyed pike, trout and burbot) are all fish-eating species, while the less common fish hosts of these plerocercoids (for example, grayling and pollan) eat fish only at times. Unsworth was unable to identify the species of Diphyllobothrium with which he was dealing, because he obtained only the scolex and immature anterior segments of the adult from the puppies which he experimentally infested; but, from these, he concluded that the South Wales species studied by him was too small to be *D. latum* of man. He was also able to infest puppies with plerocercoids sent to him by Hickey from the Dublin area, so that this Dublin species can apparently develop to maturity both in a mammal and in birds (gulls, herring gulls and cormorants). Unsworth concluded that the Irish species is not *Diphyllobothrium latum* of man. The immature stages are not, however, enough for the identification of species of *Diphyllobothrium*.

All these workers sent specimens of the adult tapeworms obtained by them to H. A. Baylis of the British Museum, who concludes (*Brit. Med. J.*, 868, Dec. 30, 1944) that all the tapeworms obtained from the gulls represented one species, and all those from the cormorants another. Comparison of the worms obtained from the experimental mammalian hosts by all the workers led Baylis to conclude that all the workers were dealing in their experiments with a single species, which is probably the old but little-known species *D. dendriticum* (Nitzsch, 1824). In experimental mammalian hosts this species showed slight differences from species found in gulls, probably because the mammal is an abnormal host.

The question raised in the *Lancet* (475, April 8, 1944) that the species found in South Wales might possibly be *D. latum* of man, which does occur in the west of Ireland (see below) and might possibly have been brought to Britain by Polish and Norwegian refugees, as it has been established endemically in North America by immigrants, would seem to have been negatived by Baylis's decision. The whole question, however, requires further investigation, for T. E. Gibson (*Brit. Med. J.*, 200, Feb. 10, 1945) records yet another infestation of trout in a Northamptonshire reservoir with plerocercoids morphologically similar to those described by Duguid and Sheppard. These failed to infest a guinea pig, but they did infest three rats, which finally threw off the infestation spontaneously, as Unsworth's puppies did. Gibson also found plerocercoids "of a smaller type" in 40 per cent of "smaller fish" in the same reservoir, but attempts to infest rats with these have so far failed (see also T. Hare, *Brit. Med. J.*, 347, March 10, 1945). In addition to this, Dr. Peterson of Yell informed Duguid and Sheppard that a species of *Diphyllobothrium* is also endemic among freshwater trout in some of the Shetland Islands.

With regard to the occurrence of *Diphyllobothrium latum* in man in west Ireland, N. O'Connor (*Brit. Med. J.*, 737, Dec. 2, 1944), discussing multiple infestation of man with two types of tapeworm, states that the existence in Ireland of *D. latum* of man was first recorded by O'Farrell (*Lancet*, i, 466, 1916; i, 570, 1918; and *Irish J. Med. Sci.*, vi, 95; 1929). Another case was reported by O'Kelly (*Irish J. Med. Sci.*, vi, 188; 1935). The first case of multiple infestation was recorded by O'Farrell (*Irish J. Med. Sci.*, vi, 542; 1930). All these cases came from the Shannon area. O'Connor (*loc. cit.*) himself records the infestation of a husband and wife with *D. latum* in the River Erne area, near lakes not connected with the River Shannon, the wife's infestation being multiple and combined with infestation with *Taenia saginata*. Both ate perch, pike and eels, but no trout; the wife often ate undercooked meat and raw pork. The husband had never been abroad; the wife was born of Irish parents in Glasgow, which town she had visited only twice within the last twenty-three years. G. W. S. Andrews and A. C. Ogilvie (*Brit. Med. J.*, 772, June 3, 1944) record a case of multiple infestation with *Taenia saginata*. G. LAPAGE.

FORTHCOMING EVENTS

Saturday, March 24

ASSOCIATION OF BRITISH ZOOLOGISTS (at the Zoological Society of London, Regent's Park, London, N.W.1), at 10 a.m.—Tenth Annual General Meeting; at 10.30 a.m.—Dr. C. F. A. Pantin, F.R.S.: "The Interrelationship of Biology Teaching in Schools and Universities", at 2 p.m.—Dr. Stanley Kemp, F.R.S.: "Marine Investigations", at 2.45 p.m.—Dr. S. A. Neave: "The Work of the Zoological Society", at 3.30 p.m.—Mr. J. C. F. Fryer: "Zoological Interests of the Agricultural Research Council", at 4.15 p.m.—Dr. E. B. Worthington: "Freshwater Investigations".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. H. Ridley: "An Experimental Approach to Time Lapse Cinematography".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the SOUTH YORKSHIRE SECTION of the ROYAL INSTITUTE OF CHEMISTRY) (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Dr. U. R. Evans: "The Principles governing Corrosion Resistance in Metals and Alloys".

Monday, March 26

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7) at 5 p.m.—Dr. S. E. Hollingworth: "Zones of Rock Flow and Resulting Land Forms".

ROYAL INSTITUTE OF CHEMISTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5 p.m.—Dr. Harold Moore: "Industrial Non-Ferrous Alloys".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Future of Synthetic and Thermoplastic Insulated Cables" (to be opened by Mr. T. R. Scott).

Tuesday, March 27

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting. Discussion on "The Social Aspects of Television" (to be opened by Capt. C. H. Cazaly).

Thursday, March 29

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 5.30 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHIEF METALLURGIST by Midland firm to take control under the General Management of the metallurgical side of the production of cold rolled mild, alloy and carbon steel strip—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3759 XA) (March 28).

LECTURER IN THE ELECTRICAL ENGINEERING AND PHYSICS DEPARTMENT of the Coventry Technical College—The Director of Education, Education Offices, Coventry (March 29).

ASSISTANT ENTOMOLOGIST (temporary)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (March 31).

ASSISTANT LECTURER (well-qualified Graduate) FOR MATHEMATICS AND PHYSICS, at the Norwich City College and Art School—The Director of Education, City Hall, Norwich (April 3).

CHAIR OF AGRICULTURAL CHEMISTRY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (April 6).

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING of the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (April 7).

METALLURGIST GRADUATE for development work in large Steel Foundry in South Midlands—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2119.XA) (April 9).

CHEMIST on the staff of the WATER POLLUTION RESEARCH LABORATORY, Watford—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3403 A) (April 10).

FOOD CHEMIST in the Research Department of a well-known London firm to carry out the analysis of a wide range of food materials packed in metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2722 XA) (April 14).

LECTURER IN GENERAL ENGINEERING SUBJECTS, and a LECTURER mainly for ENGINEERING MATHEMATICS—The Registrar, Merchant Venturers Technical College, Bristol 1 (April 15).

WORKS PROCESS CHEMIST for new factory in India—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3705.XA) (April 17).

Senior Post as RUBBER RESEARCH CHEMIST with a large Company in the North of England engaged in rubber manufacture—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3360 XA) (April 17).

METEOROLOGICAL OFFICER CADETS, Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (April 20).

ENGINEER FOR THE POSTS AND TELEGRAPHS DEPARTMENT of the Government of Nigeria—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. D.971.A.) (April 21).

SENIOR LECTURER (ungraded) IN HISTOLOGY—The Registrar, The University, Liverpool (May 31).

UNIVERSITY CHAIR OF BACTERIOLOGY, tenable at University College Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (June 25).

HIGH-GRADE TECHNICIAN (male) for laboratory concerned with the construction of moulded applicators individually fitted to patients—The General Superintendent, Christie Hospital and Holt Radium Institute, Withington, Manchester 20.

TELECOMMUNICATIONS ENGINEER by S.E. London engineering firm—The Ministry of Labour and National Service, Appointments Department A 3(A), Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. QS 91).

ASSISTANT SECRETARY—The Royal Photographic Society, 16 Prince's Gate, London, S.W.7 (endorsed 'Assistant Secretary').

SPEECH THERAPIST—The Director of Education, Education Offices, Moss Street, Bury, Lancs.

READERSHIP IN HUMAN PHYSIOLOGY—The Registrar, University Registry, Oxford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 15, No. 3, December 1943. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Kueneman. Pp. iv+159–238. (London: H.M. Stationery Office, 1944.) 4s. 6d. net. [152

Glasgow Art Gallery and Museums. Report for Year ending 30th June 1944. Pp. 24. (Glasgow: Glasgow Art Gallery and Museums, 1945.) [162

British Coal Utilisation Research Association: Steam Engineering Department. Progress Report for Year ending April 1944, and Programme for Year commencing May 1944. Pp. 14. (London: British Coal Utilisation Research Association, 1944.) [202

A.Sc.W. Facts. Pp. 20. (London: Association of Scientific Workers, 1944.) 3d. [202

University of Leeds. Report of the Librarian for the Session 1943–44. Pp. 5. (Leeds: The University, 1945.) [222

National Smoke Abatement Society. Fifteenth Annual Report for the Year ended December 31st, 1944. Pp. 16. (London: National Smoke Abatement Society, 1945.) 2d. [222

Tools for the Next Job: a Policy of Progress through Productivity. (Published for the Tory Reform Committee.) Pp. 64. (London: Europa Publications, Ltd., 1945.) 2s. 6d. [272

Some Notes on the History and Principles of the Shepherd System of Air Disinfection. Pp. 12. (London: Shepherd's Bactericidal Aerosols, Ltd., 1945.) [272

Ministry of Health. Nurses Salaries Committee. Mental Nurses Sub-Committee. Further Recommendations and Points of Interpretation. Mental Nurses S.C. Notes, No. 2. Pp. 6. (London: H.M. Stationery Office, 1945.) 1d. net. [272

Imperial Forestry Institute. University of Oxford. Twentieth Annual Report, 1943–44. Pp. 12. (Oxford: Imperial Forestry Institute, 1944.) [272

Other Countries

Nutrition Problems in Relief and Rehabilitation: Planning for the Post-War Area. By Moses Schonfeld. Pp. vii+30. (New York: American Chapter, Religious Emergency Council of the Chief Rabbi of the British Empire, 1944.) 75 cents. [52

Newfoundland Government. Research Bulletin No. 14. A Biological and Economic Study of Cod (*Gadus callarius*, L.) in the Newfoundland Area, including Labrador. By Dr. Harold Thompson. Pp. 160. (St. John's: Department of Natural Resources, 1943.) [72

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 31: The Effect of Storage under certain Specified Conditions on the Quality of Indian Cottons. By Dr. Nazir Ahmad and A. N. Gulati. Pp. 21. (Bombay: Indian Central Cotton Committee, 1944.) 1 rupee. [72

South Australia: Institute of Medical and Veterinary Science. Sixth Annual Report of the Council, July 1943—June 1944. Pp. 12. (Adelaide: Institute of Medical and Veterinary Science, 1944.) [72

U.S. Office of Education: Federal Security Agency. Misc. No. 7: FM for Education: Suggestions for Planning, Licensing and Utilizing Educational FM Radio Stations Owned and Operated by School Systems, Colleges and Universities. By William Dow Boutwell, assisted by Ronald R. Lowdenmilk and Gertrude G. Roderick. Pp. ii+54. (Washington, D.C.: Government Printing Office, 1944.) 20 cents. [122

Ministry of Finance, Egypt: Survey Department. Geodesy in Egypt. By J. H. Cole. Pp. x+164. (Cairo: Government Press, 1944.) P.T. 50. [202

Colony of Mauritius: Department of Agriculture. Fourteenth Annual Report of the Sugarcane Research Station, 1943. Pp. ii+17. (Mauritius: Government Printer, Port Louis, 1944.) 50 cents. [202

Anuario del Observatorio Astronómico de Madrid para 1945. Pp. 374. (Madrid: Instituto Geografico, 1944.) [202

Publicaciones de la Facultad de Ciencias matematicas, Fisicoquimicas y naturales, Aplicadas a la Industria, de la Universidad Nacional del Literol. Serie Conferencias y Textos, Publicación No. 21: Teoria general de las magnitudes fisicas. Por Prof. Walter S. Hill. Pp. 112. 4 dollars. Serie Tecnico cientifica, Publicación No. 22: Combustion nuclear. Por Prof. Walter S. Hill. Pp. 72. 3.50 dollars. (Montevideo: Instituto de Fisica, 1941.) [202

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BRITISH EMPIRE SCIENTIFIC CONFERENCE

THE address on "Scientific Co-operation within the British Commonwealth" which Prof. A. V. Hill delivered to the Royal Empire Society on January 31 has claims on the close attention of all scientific workers. In the first place, it gives an account of the actual progress that has been made in implementing co-operation since the committee appointed by the Royal Society reported in 1943. In particular, the Empire Scientific Conference to be called in London by the Royal Society either later this year or, more probably, in 1946, which is one indirect result, not merely of that report, but also of Prof. A. V. Hill's visit to India, of the more recent visit of Indian men of science to Britain and of Sir Henry Tizard's visit to Australia and Canada in 1943, will call for the active support of many more scientific workers than the sixty actual delegates contemplated.

Prof. Hill said that the Conference will probably be held in two parts, the first and more purely scientific gathering being followed by a more official conference for working out concrete plans for submission to the Governments concerned. During the interval, the visitors will travel about Britain in small groups, to see British science, industry, agriculture and medicine in operation, and above all to gain by informal discussion personal acquaintance with each other's problems, programmes and ideas. The value of this informal contact is rightly stressed by Prof. Hill, as in the British Commonwealth Science Committee's report, where it formed the subject of two of the six main recommendations ; such contacts are in fact one of the most important things to implement. No organization, as we have urged repeatedly, can be an effective substitute for that full freedom of intercourse and communication, both spoken and written, which for more than five years has been severely limited by war conditions.

If it is true and right that such fundamental freedom should be restored first within the British Commonwealth and as early as possible, it is true also that these proposals to improve and extend imperial co-operation in science are also important in relation to the wider field of scientific co-operation generally, to which Dr. Joseph Needham directed attention in his plea for an international science co-operation service as a functional body parallel with the International Labour Organisation and the Food and Agricultural Office, and on which Sir Henry Dale dwelt at some length in his anniverary address to the Royal Society on November 30. Prof. Hill also emphasizes the importance for international scientific co-operation of such developments in scientific co-operation within the British Empire, and one of his reasons for urging British leadership in this field is the vital importance of building up as rapidly as possible a world organization for sharing the beneficent results of scientific discovery. Above all, it might be fittingly urged at the present time that it is essential to re-establish as early and as fully as

possible those contacts in science which will revive in the harassed peoples of Western Europe the sense of common traditions and heritage in science no less than in law and government, in humanism and in Christianity, with all that such a revival can mean to them as they address themselves to the reconstruction of their national life.

While that appears to be the setting in which Prof. Hill rightly views proposals for imperial co-operation in science, the practical tone of his address is unmistakable. His visit to India has convinced him that the best hope of friendly co-operation between India and Britain lies in the scientific, technical and medical fields. It is now probable that the Government of India will set up an Indian Scientific Office in London, and an Indian Scientific Liaison Service may be established with its headquarters in Delhi, its main overseas office in London, and branches in other countries.

Other promising developments are also noted by Prof. Hill, such as the work of the Colonial Research Committee and of the Colonial Products Research Council, and closer contact and co-operation between these bodies and the Dominions and India could scarcely fail to be of mutual advantage in dealing with many scientific, technical, agricultural or medical problems. Again, the attachment of two able scientific advisers to the Middle East Supply Centre is of special interest. In the region covered by the Middle East Supply Centre, science, particularly the biological sciences, could play a dominant part in determining the welfare of the peoples and their relations to the outside world. Problems are encountered in agriculture, irrigation and soil survey, in land conservation and erosion, in geology, meteorology and water supply, in forestry and the preservation or utilization of flora and fauna, in health and nutrition and the like, which are closely analogous to those encountered in other parts of the British Empire; and, further, neglect of the scientific factors will lead to trouble and difficulties which no political astuteness can curb or avoid.

It is, however, in his references to the specific problems in which scientific co-operation within the British Commonwealth is of practical importance that Prof. Hill's address is of the greatest interest. Here he enforces the point that such co-operation alone can provide the solution to important practical problems, some of which, such as that first mentioned by him, namely, the fear of isolation, which deters first-class teachers and research workers from accepting posts in more distant centres, have been raised in recent reports like those of the Colonial Research Committee. Their effects, and means of overcoming it, are obviously problems not for one colony or dominion alone, but for joint consideration and a common policy.

Similarly, the need for quick and frequent personal contacts between research workers in analogous fields is widely recognized; but almost certainly an imperial policy alone can ensure that air transport will supply such contacts regularly for people who are mostly not well paid and have no great political or industrial standing. Again, regular interchange of personnel between the scientific staffs of universities, industrial firms and research institutions throughout the Commonwealth must largely wait on the formulation of common arrangements, including an appropriate pension system. Allied to this is the problem of organizing and financing the training of young research workers and the higher grades of technologists and workmen by exchange between countries which have special opportunities to offer.

Another group of problems instanced by Prof. Hill as calling for co-operative attention is the combined study of natural resources and conditions—forests, minerals, land utilization, water-power, plants, animals, pests and diseases, and the application of the principles of lend-lease both to their investigation and the utilization of the new knowledge so gained. Here we touch on the question of regional research. Certain regions form natural units for research and development in particular subjects or groups of subjects, although the regions may fall, as in Africa, under the authority of different Governments. The means of securing co-operation and the sharing of effort and expense in such regions require working out; while again, in attempting a concentrated attack on a key problem, we lack the machinery for deciding on the problem and on the method, the scale and the direction of attack and the means by which the expense is to be shared.

Finally, Prof. Hill refers to the question of science and imperial defence, and faces frankly the fact that scientific workers have been troubled in the past as to secrecy being a cover for inefficiency, and the danger of its breeding fear and suspicion. He insists on the need for critical minds and up-to-date methods, for contact with recent scientific discoveries and industrial technique, and for interchange between scientific workers in Government service, in industry and in the universities throughout the British Empire. The relations between civil and military research need to be worked out critically and with imagination; here it may be noted that three of the nine points of imperial defence which Lord Chatfield pressed in the House of Lords on March 7 as requiring investigation closely concern scientific workers. Two of these questions, whether our statesmen require better opportunities of informing themselves on strategical and technical problems of defence, whether service Ministers, when possible, should serve three or four years in their departments so as to master the technical problems, could well be included in the agenda of the proposed conference. The third question, whether the defence of the Empire and the security of the British people could be removed from party strife, or some other means devised to lessen political differences on the basic problems of defence, might also be considered.

Prof. Hill's address shows clearly that a definite practical programme and not mere generalities can be placed before both sessions of the forthcoming Empire Scientific Conference when it meets. There will be ample scope for critical discussion and imaginative planning; but if the Conference is to result in the bold executive action desired, scientific workers must manifest their interest and support in

no uncertain manner in the months preceding its assembly. The application of the methods of biological science, in its widest sense, to the problems of general welfare, and of physical and engineering science to economic and industrial problems, calls for much effort by the individual scientific worker, and, as Prof. Hill points out, may involve facing political as well as scientific and technical issues. Not everyone who recognizes as desirable that fuller and more effective co-operation among men of science for which Prof. Hill pleads will feel as sanguine as he is that such co-operation in the British Commonwealth will appreciably influence the relations of the world as a whole; but it must help rather than hinder international co-operation generally. That the closer co-operation of scientific workers and fuller and freer contacts between them are important factors in the continued advance of science cannot be denied. They are indeed essential conditions in order that mankind may enjoy those higher standards of health and welfare which science has put within our reach. Prof. Hill's address should stir scientific men to take their part not only in thinking about the technical and scientific aspects of the special problems he has indicated for consideration by the Empire Scientific Conference, but also, and equally important, in educating their fellow-citizens as to what is at stake. They can prepare the way for the measures required to implement such co-operation, and to establish and safeguard that code of common ethical standards which, as Prof. Hill so emphatically urged, will be a safeguard against the abuse of science either in peace or in war.

A PHYSICIST LOOKS AT GENETICS

What is Life?

The Physical Aspect of the Living Cell. By Prof. Erwin Schrödinger. (Based on Lectures delivered under the auspices of the Dublin Institute for Advanced Studies at Trinity College, Dublin, in February 1943.) Pp. viii+91+4 plates. (Cambridge: At the University Press, 1944.) 6*s*. net.

As a result of the War, many scientific workers have been too busy with the applications of science to keep up even with the development of their own branch. Schrodinger, as an exile in neutral Eire, has found the leisure to study another, namely, genetics, which he describes as "a new branch of science, easily the most interesting of our days". I wonder if posterity will find crossing-over as interesting as exchange energy, or mutation as atomic transition. However this may be, every geneticist will be interested in Schrödinger's approach to his or her science.

Schrödinger sets out to answer the question "How can the events in space and time which take place within the spatial boundary of a living organism be accounted for by physics and chemistry?". He believes that they can, but not by present-day physics and chemistry. Accepting the view, first, I think, put forward by Koltsoff, that a chromosome is a giant molecule, Schrodinger describes it as an aperiodic crystal. Thus it may be expected to have some of the properties of a crystal, including that of self-reproduction, and yet to be of so highly complex a structure that it can act as a "code-script" for the development of an organism He thinks that just because a gene is of molecular dimensions, and there are only one or two genes of a kind per cell, one cannot apply statistical mechanics to the behaviour of genes. This is perhaps not quite certain; for an organic catalyst can, in favourable circumstances, transform more than 100,000 substrate molecules per second. If genes are catalysts of this order of activity, even a single gene requires statistical treatment.

Much of the book is devoted to mutation, and the author not merely accepts Delbrück's account of this process, but also writes that "If the Delbruck picture fails, we would have to give up further attempts". This seems a rash statement from a quantum physicist The modern 'picture' of an atom is not superficially very like Bohr's picture, for discrete orbits of electrons have been replaced by a continuous probability distribution. Yet Bohr's theory explained so much that it was hard to believe that it would be so greatly modified.

Actually I believe that the Delbruck picture will have to be modified profoundly, for the following reason. Schrodinger (p 65) states that the single event which produces a mutation "must be an ionization or similar process". Lea and Catcheside, in unpublished work communicated to the Genetical Society, which they very kindly allow me to quote, produce strong evidence that many, if not all, lethal mutations produced by irradiating *Drosophila* spermatozoa are due to chromosome breakage followed by restitution; and in *Tradescantia* they[1] calculate that "at least 17 ionizations must be produced in a chromatid to cause a break". In spite of this they think that the 'target-area' gives the size of the gene correctly. In fact, as so often in quantum mechanics, a simple theory gave fairly correct results, but nevertheless had to be modified.

Again (p. 64), the fact that the mutation-rate of wild-type genes is more enhanced by temperature than that of less-stable mutant genes is neatly explained on quantum-mechanical grounds. But Fabergé and Beale[2] found that the mutation-rate of a very unstable gene actually fell off at high temperatures. Perhaps there are more things in chromosomes than are dreamt of even in wave mechanics.

I make these criticisms not from any desire to denigrate the book before me, but because many geneticists will read it, and all of them should. And not only geneticists. The physiologist who can assimilate the idea that a living organism feeds on negative entropy will come back to the study of metabolism with a slightly novel set of questions to ask. Nevertheless, a whole series of biological problems are not raised. Many biologists have found it impossible to explain the facts of organic regulation on mechanistic lines. Prof. Schrodinger's views on genetics are so interesting that I hope he will tackle this problem, too, in another book. In a living organism we find a hierarchy, so to say, of normal conditions. A man does his best to keep the partial pressure of carbon dioxide and the concentration of bicarbonate ions in his plasma constant. If he fails in either respect, he will use his lungs, kidneys, or both, to bring their ratio, and therefore his pH, back towards normal. But even pH is less important than an adequate oxygen supply. And so on. A mathematical physicist might be able to find physical analogies, or even explanations, for such facts as these.

A mechanist must either give a mechanistic account of mind, or turn a somersault. In his epilogue, Schrödinger does the latter with very great elegance, and adopts a metaphysical position which is roughly that of Samkara Acharya. There is only one soul; the difference between yours and mine being an illusion. I think that here, too, the history of quantum mechanics suggests that the truth may be somewhere between mechanism and advaita metaphysics. There is no way of distinguishing between the two electrons in a hydrogen molecule; you cannot put a spot of red paint on one of them. This fact makes a difference to their behaviour. Nevertheless there are two electrons, not one. Perhaps the relation between two souls is a little more like that between two electrons than between two tables, and these philosophical problems will be solved, or at least transformed, when our descendants learn to apply to mind the kind of analysis which Schrodinger has applied to matter.

However that may be, the book is one to which one comes back again and again. I have lent it to several genetical colleagues, and the verdict has been uniformly favourable. We may disagree with details, or even with fundamental principles, but we cannot stop reading it before the end. Unfortunately, it contains only 93 pages. There are 93 elements, but 738 isotopes have so far been described. Perhaps we may hope for a book of 738 pages on biology in general. Prof. Schrödinger need not doubt that it will find readers. J. B. S. HALDANE.

[1] *J Gen.*, **44**, 216 (1942).
[2] *J. Gen.*, **43**, 173 (1942).

PSYCHOLOGY OR RELIGION?

The Lady of the Hare

Being a Study in the Healing Power of Dreams. By Dr. John Layard. Pp. 277. (London: Faber and Faber, Ltd., 1944.) 12*s*. 6*d*. net.

THIS volume, which is attractively produced and well illustrated, purports to be the first verbatim account ever published of a dream-analysis on Jungian lines. (Jung's numerous own seminar accounts of dream analyses published in limited number for the use of his students may not have come to the notice of the author.) In Part 1, twelve professional sessions are described in which a number of dreams and so-called visions of a woman patient were discussed. This is followed by a brief theoretical discussion, a summary of the dream process, and a description of the subsequent remarkable development of the patient's mentally defective daughter. Since one dream of the patient contains the figure of a hare which she is meant to kill or sacrifice, Part 2 of the book deals with the mythology of the hare, and the author follows up the hare motive in myths and folklore of India, China, Egypt, Africa, North America, Europe and classical antiquity. In Part 3, more dreams about hares and rabbits are communicated.

As Dr. Layard, the anthropologist, has the well-known informative "Stone Men of Malekula" to his credit, one opens this book by Dr. Layard, the psychologist, with high expectations of finding a full and well-substantiated account of a case-history illustrating the practice of Jung's analytical psychology. The author, however, does not fulfil these expectations, but expounds his own psychotherapeutic technique and healing powers, which bear little relation to Jung's practice and theory of analytical psychology. The result is a book which will fill the informed student of analytical psychology with dismay and induce the uninformed reader to identify the Jungian method with that of the author, which is a fallacious assumption.

Jung defines the aim of analytical psychology as that of individuation. The author defines it (p. 18) as that of salvation, thereby discarding the scientific phenomenological approach of Jung, identifying psychology with religion and the psychologist with the priest or magician (the patient's: "You are a minister of God", p. 47), in defiance of the teachings of Jung (cf. "The Relations between the Ego and the Unconscious"). Nor is the author following Jungian practice in treating the transference of the "Saviour Archetype" by "disclaiming it on every occasion when it arose" . . . "emphasizing the obvious unsuitability of any such personal projection" (p. 82), for according to Jung (*loc. cit.*) the problem of transference defies rationalizations of this kind. However, most alien to the point of view of analytical psychology, which refrains from making sweeping, scientifically untenable claims and conforms to the standards expected from proper clinical psychological research, are two basic aspects of the account given of dream-analysis which reveal the author's unfamiliarity with, or disregard of, the Jungian practice of dream-analysis.

One is that the author gives the unsuspecting reader the impression—and appears to share it himself—that the twelve interviews described, comprising the discussion of twenty-five dreams and visions and covering a period of about two and a half months, perfected a cure comparable with that attained in the gradual process of growth facilitated by a proper analysis. His insistence on quick results ("The deeper the analysis the quicker the cure", p. 20; "The whole interview had lasted just ½ hour, but it had been enough", p. 36; "As last week, the whole interview lasted less than ¾ of an hour", p. 58) betrays the anthropologist's fascination for the magic practices of the medicine man, while his belief in miraculous and spectacular healing reminds one of the claims of faith-healers. The claim that his twelve-interview treatment is representative of Jungian practice shows grave lack of knowledge of the work of Jung and his school.

The other main aspect incompatible with Jungian principles and practice is the victimization of the patient during the sessions, as described. Even granting that the expression "verbatim account" may be an exaggeration and should not be taken literally, there remains the fact that undue prominence is given to the author's intuitions about the dreams and his suggestions to the patient, while the patient's own spontaneous associations are partly not admitted and partly not related. This practice is alien to that expounded by Jung.

Thus the main part of the book gives the reader insight into Dr. Layard's psychotherapeutic technique and powers, but the reader must beware of confusing this, as the author has done, with the technique of Jungian analysis.

In Part 2, when collecting the hare motive as found in mythological material of primitives and the ancients, Dr. Layard, the anthropologist, is at work once more, and this part, though of little import for the case described, forms a work of reference on the hare motive which will be very useful for the student of mythology.

The author would be well advised to write the promised second volume without reference to Jung's analytical psychology; for the reference to Jung is apt to create confusion and do a disservice to Jung, and incidentally to the author himself.

H. J. JACOBY.

BROADCASTS ON FARMING

'Farming Talks'

By W. S. Mansfield. Pp. 119+8 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 7*s*. 6*d* net.

Farming To-day Broadcasts

Vol. 2. A Series of Agricultural Education and Technical Development Broadcast Talks. Pp 130+12 plates. (Worcester. Littlebury and Co., Ltd, n.d.) 7*s*. 6*d*. net.

THESE two groups of farming broadcasts are presented without alteration in form, a procedure which has both advantages and demerits. For those who did not hear the original talk or discussion, the structure, particularly when dialogue, does not make for easy reading and there are occasional difficulties of meaning. Those who have heard most of the broadcasts—and they will probably be the majority of readers—will be able to recapture the atmosphere and enjoy again the accents of the speakers.

Since 1937 Mr. Mansfield has been a regular and notable contributor to B.B.C. broadcasts on farming topics—he takes part in six of the discussions in the second series of 'Farming To-day'. The talks and discussions of this second volume were given in 1943 and the first quarter of 1944, and are arranged chronologically. About half of the 'Farming Talks' were given before the War, and the remainder nearly all in its first two years. The illustrations in both volumes are well reproduced; their function is decorative, having no special reference to textual matter.

War needs have changed the character of these broadcasts. Mr. Mansfield's earlier talks were aimed at a wider audience; though intended for farmers, they were designed also to interest the townsman in the land and its problems. There are discussions—for example, one with Dr. Sanders on high and low farming—but mainly they are straight talks, with at the end perhaps a short dialogue with his farm bailiff or rat-catcher, for illustrative purposes. In these he succeeds very well in catching something of the spirit of the land. Talking, in 1938, on successful farming, he quotes Xenophon to the effect that the difference between those who succeed and those who do not is a difference not of knowledge but of care in management. To the extent of conceding that knowledge, experience, good land and adequate capital are not enough without character—and especially adaptability to changing conditions—Mr. Mansfield agrees.

Great changes have been forced on British agriculture by war needs; after the War there must be a further change, which, whatever else it may be, will not be a reversion to the conditions of 1939. The war-time broadcasts have been educational and propagandist in character, aiming at spreading new ideas, publicizing the results of agricultural research, and generally supplementing the work of the war agricultural committees.

Some of the contributors to "Farming To-day Broadcasts" are farmers, some are specialists. Welsh hill land improvement, sugar beet, haymaking, care of machinery and composting straw are among the topics of discussion Not all the talks are concerned with immediate needs; particularly where livestock are involved (because of their low reproductive rate) there must be long-term planning There has been a great decline in the sheep population of Britain. Four discussions deal with hill sheep, arable and grassland flocks, and disease, and consider probable sources and methods of management in post-war agriculture. Naturally none of the subjects is treated at any great length.

HYDRAULICS IN THEORY AND PRACTICE

A Treatise on Applied Hydraulics

By Prof. Herbert Addison. Third edition, revised and enlarged. Pp viii+614. (London Chapman and Hall, Ltd., 1944.) 32*s*. net.

PROF. ADDISON explains, in his preface, that his aim in writing this book was to present a compact summary of the fundamental principles of hydraulics and the manner in which they are applied, and he expresses the hope that the book will meet the requirements of three classes of readers—the engineer in practice who desires to keep in touch with modern developments in hydraulics, the general student of engineering and the student who wishes to specialize in the subject and who desires a reliable basis for further study. In these aims he has succeeded admirably.

The first part of the book deals with theoretical principles and the second with practical applications, the whole being extremely well illustrated by diagrams and photographs. A striking feature is the arrangement of the subject-matter; thus the numerous worked examples, and problems for solution by the student, are collected together towards the end of the book and reference is made to them when illustration is necessary. Such arrangement has the advantage that the continuity of the text is not interrupted and, in any section, the student may obtain, in the first instance, a clear and concise statement of the engineering aspect of each problem as a background to his study of the theoretical discussion.

The second part of the book introduces a wide range of applications, including the flow of water in pipes, channels and streams, the control of water, viscous flow, hydraulic turbines, pumping machinery, power transmission and hydraulic measurements.

From the method of presentation there is ample evidence not only of Prof. Addison's breadth of knowledge, but also of his experience as a teacher and his appreciation of the problems which confront the teacher and student alike, in dealing with the complexities of a subject in which it is particularly difficult to apply the results of theoretical investigation to the conditions which prevail in practice.

While this is an excellent text-book for the use of students preparing for university and institution examinations, it is much more than that, for it summarizes the results of modern research, is equipped with a comprehensive bibliography of recent publications, and its descriptions and illustrations refer to up-to-date installations. Civil, mechanical and electrical engineers will find it a most complete and informative book of reference on hydraulic engineering.

J. B. TODD.

Your Daily Bread

By Doris Grant. Pp 94. (London Faber and Faber, Ltd, 1944.) 4s. 6d. net.

THIS little book covers a lot of ground. Essentially, Miss Grant sets out to prove that white bread—or "murdered bread" as she prefers to call it—is responsible for much of our poor and indifferent health, and she pleads the case for wholemeal bread as the remedy. The book contains much scientific material, and although some of it is not very critical, the case is skilfully presented It is suggested, for example, that because nicotinic acid helps to create skin beauty, 'one of the best and easiest ways of ensuring a flawless complexion is to eat whole-wheat bread".

A section of the book deals with the place of bread in a balanced diet and gives specimen menus. Miss Grant abhors imported or processed foods of any kind, and she is supported in this by Sir Albert Howard, who contributes a chapter on the importance of fertile soil for the production of best-quality wheat. Sir Albert includes all canned foods, chilled meat and frozen fish with white bread as "murdered foods", and claims that they are responsible for the poor physique of our urban population. Further, he condemns the use of artificial manures of all kinds. Another chapter reproduces the Cheshire memorandum, a statement by a number of medical practitioners from that county on some general aspects of nutrition including the arguments in favour of wholemeal bread.

The book concludes with a number of recipes for cakes, scones, biscuits, etc., using wholemeal flour. Perhaps the most important recipe is that for the 'Grant loaf'. A sample was made for the reviewer, strictly according to instructions but using ordinary salt and cane sugar, by a skilled baker. When eaten at tea by a family of four, two preferred it to National bread; however, when two days old, one only was still enthusiastic. It is not easy to break dietary habits

School Physics

By T. M. Yarwood. Part 2. Pp. x + 438. (London: Macmillan and Co., Ltd., 1945.) 7s. 6d.

THIS book includes all that is required for the various School Certificate examinations. Together with the previous more elementary part, it provides the basis for a sound school course in physics. Good features are the frequent references to the applications of science to everyday life; the inclusion of a chapter on radio; and the numerous problems solved in the text.

In the reviewer's opinion, however, it is a mistake to cover the whole of physics in two books. The inevitable result is that the presentation is not so attractive as in well-known series of books covering the same ground. Having attempted it, dullness might have been avoided by the lavish use of half-tones, but there are only half a dozen in the 400 pages.

There are a few slips and inadequacies: two may be mentioned. On p. 73 it is said that the gas ejected from a jet-propelled plane "presses on the air behind the aeroplane, and the machine is thus pushed forward". On p. 131, stress is laid on the thermal capacities of water and mercury, water and sand, etc. The effect of their relative densities should also be mentioned when comparing the thermal capacities of two bodies, for example, two thermometers.

J. P. STEPHENSON.

On a Class of Linear Transformations Connected with Group Representations

By Lars Gårding. (Meddelanden från Universitets Matematiska Seminarium, Band 6) Pp 125 (Lund C. W. K. Gleerup, 1944.) n p

BASIC spinors are defined with reference to the equation $T^{-1}\gamma_i T = \Sigma a_{ij}\gamma_j$, where γ_i represents a set of anti-commuting matrices, $[a_{st}]$ is the matrix of an orthogonal transformation, and T is the matrix of transformation for basic spinors. Dirac's equation for the electron is of the form $\nabla^2\psi = k^2\psi$, where ψ is a basic spinor. The same equation, but with ψ representing quantities of other types, occurs in other contexts in quantum theory and nuclear physics.

Dr. Garding sets himself the problem of investigating the generalized equation $S^{-1}V_j T = \Sigma a_{jk}V_k$, where V_j represents a finite set of matrices, and S, T, and $[a_{st}]$ are any representations of a continuous group, in particular of the orthogonal group with $S = T$ His applications are concerned mainly with the solutions of $\nabla^2\psi = k^2\psi$ for different types of quantity ψ.

In many instances the constructions seem unnecessarily elaborate, and this makes the thesis difficult to read. It would appear very probable that the principal conclusions could be obtained in a more direct manner. Nevertheless, the thesis is very interesting and suggestive, and many detailed formulæ are obtained which in themselves have some value. It shows considerable mastery over many aspects of group representational theory, and many known results are recapitulated incidentally.

The work shows considerable promise, and future publications by the author will be awaited with interest.

D. E. LITTLEWOOD

Principles of Magnetic Crack Detection

A Practical Treatise specially written for those about to Operate the Process. By H. Bevan Swift. Pp. vi + 105. (London: E. and F. N. Spon, Ltd., 1944.) 10s. 6d.

MAGNETIC methods have proved useful in the detection of cracks, too inconspicuous to be seen without such aid, in steel. This handbook is in the main a description of the apparatus for carrying out such tests in the laboratory or workshop. Several commercial forms of instrument are described, with a general account of the principles of the method. In one type a direct current is passed through the object being tested, and the concentrated field at the edges of a crack is made visible by pouring on a suspension in light paraffin of a highly magnetic preparation of iron oxide. In the second type, suitable for steels with a higher retentivity, a heavy but very short electrical impulse is sent through the object, and the ink is applied afterwards. Only actual experience enables an observer to decide on the significance of the indications given by the magnetic ink, and to distinguish between cracks and accumulations of the magnetic material caused by sudden changes of section or by casual scratches. Methods of demagnetization have to be applied when, for example, parts for aircraft are being tested.

There is a short note on the testing of bars by comparison with a standard, using a null method. Actually, this plan has been used extensively in some works for the testing of small parts, such as chain links, for correct heat treatment, a definite relation being found between the hardness and the magnetic properties, so that a very rapid sorting of correctly from incorrectly treated parts is possible.

ARTIFICIAL PRODUCTION OF COAT COLOUR IN THE ALBINO RAT

ITS RELATION TO PATTERN IN THE GROWTH OF HAIR

By DR. ALEXANDER HADDOW, DR. L. A. ELSON and DR. EDNA M. F. ROE

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DR. K. M. RUDALL

Textile Physics Laboratory, University of Leeds

AND

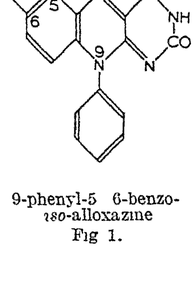
G. M. TIMMIS

Imperial Chemical Industries, Ltd., Manchester

DURING experiments on growth, which were designed to test the action of a series of flavins, a hitherto undescribed property was encountered in one of these compounds (9-phenyl-5 : 6-benzo-*iso*-alloxazine[1]), the structure of which is shown in Fig. 1. Quite unexpectedly, injection of 20–30 mgm. of this substance, in albino rats, produced an orange-yellow pigmentation of the hair. It was then observed that the coloration so produced is usually restricted to certain areas of the coat, in a way which varies considerably from one rat to another, but nevertheless conforms to a characteristic type of pattern (Fig 2), of which the most striking feature is a pronounced degree of symmetry about the longitudinal axis. Study of some scores of similarly injected rats from the same albino colony soon revealed the regular recurrence of pattern types, which it was comparatively easy to arrange as a roughly transitional series: these facts conveyed a strong impression of a certain unity of design, in which each individual represents only one stage in a continuous rhythmic process. That the pattern which may be elicited in individual animals is variable was proved by administration of the compound at intervals of one to three weeks, fresh zones of colour appearing in response to each such injection: hence its form depends (in the majority of cases at least) upon a fluctuating process, and not upon one which is fixed, or pre-determined, genetically or otherwise.

Relation of Pattern to the Growth of Hair

That the developmental process involved might concern the regeneration of hair was suggested by a number of facts. Dry[2] recorded that growth of hair on the flank of the rat may be restricted to a strip about half an inch wide running along the length of the body: such a band of growing hair had frequently been observed by the present authors in earlier work, and the irregular distribution of hair regeneration in the rat had also been noted by others[3,4]. In experiments to test this hypothesis—that the pattern-form is determined by the growth of hair—normal rats were shorn dorsally and laterally from the level of the ears to the root of the tail and down to a low ventro-lateral level, and the subsequent course of regeneration was then plotted, at intervals of a few days. At once it became apparent (Fig 3) that only limited regions of the coat are regenerating hair at any given moment, that these areas are disposed in a symmetrical arrangement similar to the patterns revealed by injection of the specific *iso*-alloxazine, and that their variety is due to the varying rate of progress of the growth-wave front. It was further observed that the advance of the wave is in general more rapid on the back and belly, and slower on the sides, and that the growth-wave cycle, traversing the surface of the body, is complete in a minimum period of approximately six weeks. But the whole cycle may be greatly disturbed, and prolonged, by factors connected with nutrition, season, lactation, and age. From these experiments it seems probable that the rat coat is replenished by a complex series of regular waves; in individual animals the pattern may be modified by isolated bursts of growth, or by a sudden subsidence.



9-phenyl-5 6-benzo-*iso*-alloxazine
Fig 1.

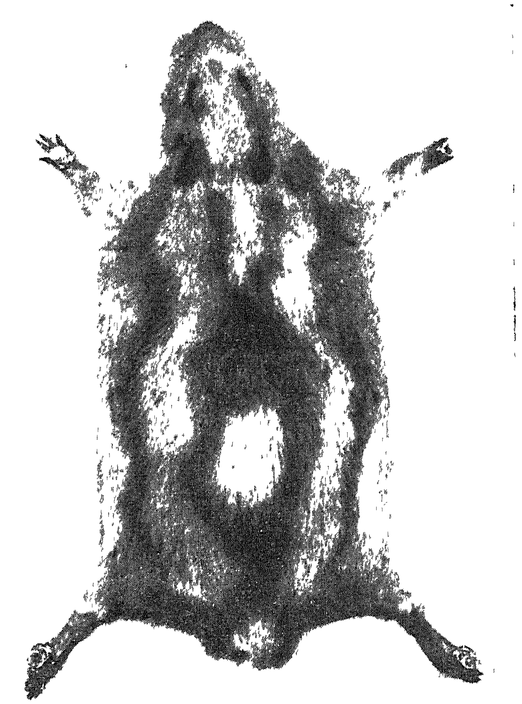


FIG 2 COLOUR PATTERN PRODUCED BY TWO INTRA-PERITONEAL INJECTIONS (AT AN INTERVAL OF ONE WEEK) OF 25 MGM. 9-PHENYL-5. 6-BENZO-*ISO*-ALLOXAZINE IN ARACHIS OIL (FILTER EMPLOYED: ILFORD TRICOLOUR BLUE NO. 304).

It now appeared that the hair coloration produced by 9-phenyl-5 : 6-benzo-*iso*-alloxazine is due to a localization, in growing hair but not in non-growing areas, of the injected compound or of a derivative; and evidence confirmatory of the latter point was soon obtained from direct examination of the hair pigment itself.

Nature of the Hair Pigment

In order to isolate the pigment, several grams of the coloured hair were treated with glacial acetic acid; after addition of chloroform, removal of the acid with water, and chromatography of the chloroform extract, the hair pigment was obtained as an orange-yellow fluorescing substance, the ultra-violet absorption spectrum of which showed the presence of the injected compound or of some simple derivative which is spectroscopically indistinguishable under the condi-

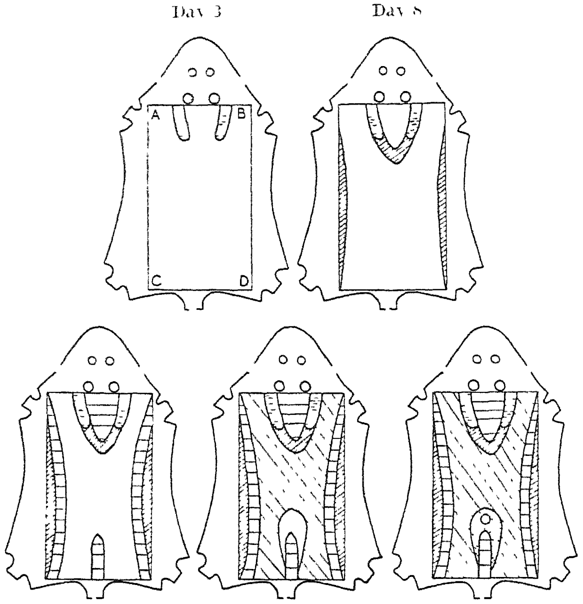


FIG 3 REGENERATION OF HAIR AT 3, 8, 14, 30 AND 35 DAYS AFTER SHEARING THE AREA OF *ABCD* SIMILARLY HATCHED AREAS ARE THOSE IN WHICH HAIR IS GROWING AT THE SAME TIME AND IN WHICH THE ALLOXAZINE PIGMENTATION WOULD DEVELOP IN RESPONSE TO ADMINISTRATION OF THE COMPOUND AT ABOUT THAT TIME.

tions employed; by this means it was calculated that there is approximately 0·1–0·2 mgm. of 9-phenyl-5 : 6-benzo-*iso*-alloxazine in the fluorescent eluate obtained from 1 gm. of hair.

The derivation of the hair pigment from the administered compound had thus been virtually proved, and an explanation obtained of its selective localization, namely, to those tracts of hair alone which are in active growth at the time of injection.

Mechanism of Localization

It was next found possible to indicate the mechanism of such localization from a study of the blood capillary circulation to the hair follicles, in rats which had previously been sheared as described. Visualization of the capillary system, in permanent preparations (achieved by the injection, under ether anæsthesia, of 1 ml. of a 15 per cent solution of chlorazol sky blue *FFS* into the femoral vein), revealed that by far the greatest density of capillaries occurs in those positions which correspond to the advancing edge of the growing hair, with a sharp cut-off at the receding edge. This observation is believed to be entirely new; it is, of course, highly suggestive, not only of the means by which the growth-wave progresses, but also of the way in which the circulating pigment enters the cuticle and cortex of the growing fibre. It would seem reasonable to infer that the constantly moving patterns of hair-growth appear in response to rhythmic alterations in the distribution of blood to the hair follicles, so that, as capillaries close down, the growth of hair recedes, while at the same time capillary activity is apparently spreading to other regions, in which the follicles at once react, and growth of hair is resumed. It is also likely that the pigment enters growing areas partly because these are the only ones in sufficiently active interchange with the general circulation. Such an interpretation was strongly supported by capillary visualization in rats which had been both sheared and injected with 9-phenyl-5 · 6-benzo-*iso*-alloxazine, all these procedures being carried out within one week in order to obtain near correspondence By this means it was possible to study capillary density, the position of the wave front, and the pigmented tract simultaneously, in a single preparation, and to show that they have precisely the same distribution

Some attention has also been paid to the mode of chemical transport of the compound, and particularly whether this might be brought about in combination with cystine in the elaboration of keratin. Direct evidence is here less easily obtained, but it may be said that the alteration in urinary sulphur partition produced by injection of 9-phenyl-5 · 6-benzo-*iso*-alloxazine (in an experiment by Dr. F L. Warren) is at least consistent with conjugation between the pigment and cysteine.

Chemical Specificity : Coloration and Absorption

The phenomenon was at first believed to depend upon a high degree of chemical specificity No pigmentation had been noted in earlier and similar experiments with the first five members of the homologous series of 9-alkyl-5 : 6-benzo-*iso*-alloxazines, that is, those compounds in which the phenyl group of 9-phenyl-5 6-benzo-*iso*-alloxazine is replaced by a methyl, ethyl, *n*-propyl, *n*-butyl, or *n*-amyl group. Closer inspection has, however, shown that all these compounds do in fact produce slight traces of coat coloration, which is nevertheless far short of the intensity resulting from 9-phenyl-5 · 6-benzo *iso*-alloxazine A very satisfactory direct correlation has been established between the intensity of coloration produced and the excretion of a pigment, for the most part identical with the administered substance, in the fæces and urine : from this it is obvious that the outstandingly active compound is equally outstanding in its rate of elimination Assuming the rate of output reflects the rate of uptake of the compound from the tissues, it is concluded that the intensity of coloration produced is correlated, within this series, with ease of absorption, and that such is conferred by the phenyl group to a marked degree. Among related substances, a slight degree of hair pigmentation is induced by 9-phenyl-*iso*-alloxazine, that is, the compound differing from 9-phenyl-5 : 6-benzo-*iso*-alloxazine in the absence of the angular ring.

Other Aspects

In a topic of such obvious and broad interest from both the biochemical and the zoological aspects, many other features have emerged, or are being investigated, relating to the physiology of hair growth and animal pigmentation For the purpose of the present communication some of these may be summarized more shortly. It has been noticed, for example, that for any group of follicles, both capillary activity and hair growth are inhibited for some time after the cessation of a period of activity. With reference to this, an attempt is being made to determine the effect on the wave front of areas which have been rendered out of phase by epilation. There is also some evidence that the capillary waves move not continuously but in a series of pulses, and it is an interesting possibility that this rhythmic activity of the capillary wave front may be related to some similar rhythm in the sympathetic nervous system. This is especially so in view of a suggestion, based on the observation that concave sections of the wave

front occasionally tend to 'fill', and so smooth themselves out, more rapidly than the entire front advances, that the movement is dependent upon the release in the tissues of a chemical substance, which might accordingly reach a higher local concentration in the troughs of the pattern than at the crests. However, such a neurohumoral mechanism still remains to be fully tested by experiment.

The pigmentation phenomenon is being studied further in relation to sex, age, genetic constitution, and species. It has been noted that the intensity of pigmentation following injection tends to be slightly greater, other factors being equal, in male rats than in females. In practically all cases the pattern evoked was of similar type and behaviour in hooded rats (of constitution *CCss*), in coloured rats (*CCSS*), and in albino rats of the constitutions *ccss* and *ccSS* : thus there is no indication that the pattern revealed is related to a genetically determined pattern already present, whether manifest or latent (For assistance in the isolation of these genotypes we are much indebted to Dr. P. C. Koller) Some allusion may also be made to the possible affinity between the capillary and hair-growth pattern in the rat, and striped or banded pigmented patterns in other mammals.

So far as the behaviour of 9-phenyl-5 : 6-benzo-*iso*-alloxazine in other species is concerned, only brief mention may here be made of its effects in mice. No action of any kind has been observed following administration of the compound (by injection or by feeding) to stock albinos or mice of the *R* III and Strong *A* pure lines. On the other hand, prolonged feeding (over many months) to black-eyed or so-called 'dominant' whites has apparently resulted in a slow increase of yellow pigmentation, although only very slight in intensity, confined to the dorsum and flanks. It by no means follows that the *iso*-alloxazine most effectively absorbed by growing rat hair is likely to be the most penetrating in other species, and having regard to the interest which would attend any extension of the phenomenon to mice, other compounds are being studied with this consideration in view.

Lastly, from the chemical side alone a wide field of inquiry can be opened up. How far molecular constitution may be modified, while still retaining this curious property, and how far the colour of the pigments themselves can be varied, within these limits, have so far only been studied in a very preliminary way. However, data have already been obtained concerning various colourless degradation and oxidation products of 9-phenyl-5 : 6-benzo-*iso*-alloxazine, which may conceivably have some bearing upon the chemical basis of albinism. Also, it may be of importance to relate these synthetic compounds to the so-called 'xanthic' pigments, of both known and unknown molecular structure (and including the butterfly wing pigments and other pterins), such as possess physiological importance or have a wide distribution in Nature.

Poulton, in his book on the colours of animals[5], directed attention to what he classified as 'non-significant' colours, that is, pigments without physiological value in respect of their colour as such But he also stressed their importance, as the material out of which natural selection can create '*significant*' colours, namely, those with special functions in protection, concealment, mimicry, adornment, and so on. We may conjecture that if a mammalian species, in which the growth of hair followed the same rules as apply in the rat, were to form a pigmented metabolic product with the properties of the *iso*-alloxazine, coat colour would inevitably result. It is then a legitimate surmise, following Poulton, whether such an arrangement might not become genetically fixed, or subject to natural selection, and thus confer some permanent biological advantage, protective or otherwise. This, however, is a matter of speculation. So far we can only say that the alloxazine colouring is adventitious and artificial, but may be potentially significant, in Poulton's sense, as well.

It is hoped in due course to publish a fuller account of this investigation elsewhere.

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DORMANCY IN BRITISH-GROWN WHEAT

By E. N. GREER and J. B. HUTCHINSON

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BEFORE the War, only a relatively small percentage of the wheat used in bread in the British Isles was home-grown. During the War, however, the acreage of home-grown wheat has more than doubled, and a large proportion of this wheat is used in bread-making grists (on occasions as much as 60 per cent of the grist). This in turn has raised the question of the most suitable varieties for bread-making. Unfortunately, this is not a simple question to answer since the quality of wheat is influenced by season and environment. Nevertheless, the National Institute of Agricultural Botany has recently issued a report giving broad recommendations based on the results of trials carried out over a long series of years.

In 1941 and particularly in 1944, a further problem arose. The weather at harvesting was unusually wet, and as a result much of the wheat sprouted in the field. As is well known, the effects of sprouting on the commercial value of a wheat crop are serious. Not only is the grain useless for seed, but also its value for milling purposes is greatly impaired. The enzymes produced during germination reduce the baking quality of flour, giving rise to undesirable characteristics in dough and bread which cannot be rectified by treatment. The diastatic activity of a wheat (normally expressed as the 'maltose figure') is a measure of the extent of germination, and in an effort to lessen the damaging effects of sprouted home-grown wheat the Ministry of Food issued instructions that no wheat must be used with a maltose figure exceeding 3 per cent. Even so, this type of damage in varying degree has been evident in much of our bread—the crumb is doughy and the loaf cuts badly—and in routine surveys of the quality of commercial bread during November and December last, as much as 25 per cent of the bread was affected.

The ease with which a freshly harvested seed germinates is linked up with the extent to which it shows dormancy ; some seeds will only germinate after a prolonged period of dry storage. The phenomenon has received attention from several investigators, notably Harrington[1] and Crocker[2]. Crocker

has pointed out that most species of wild seed can show a very prolonged dormancy which serves as a natural protection for the preservation of the species. In cultivated varieties the phenomenon is far less evident but still persists in varying degrees. The frequent occurrence of dormancy in home-grown new crop barley, especially in the colder and damper north of Britain, is well known to maltsters, who find it necessary to dry such grain in a kiln and store it over a period of weeks or even months to secure the rapid and even germination essential to their process. Bishop[3] has also recently recalled the observation of Duchartre[4] on the variations of the germinative energy of barley at, and about, harvest time. Duchartre noted that while barley grain in the milk stage was capable of germinating readily under suitable conditions, upon ripening the power of rapid germination steadily diminished, passed through a minimum, and thereafter improved to a maximum from which it was very slowly reduced with age. It is, therefore, usual to distinguish the ripe stage of barley, at which it is ready for harvest, from the so-called mature stage at which it is able to germinate readily, and the recovery process is termed 'maturation'. The length of the dormancy period and the rate of maturation are usually considered to be a function of the conditions of temperature and moisture content in which the grain finds itself; a warm, dry condition hastens maturation, and conversely cold and damp retard it. However, in any sample of dormant grain, representatives of all stages of dormancy are usually to be found; hence germination tests show uneven response with time, and are, of course, liable to considerable sampling error.

Little attention has hitherto been paid to the study of dormancy in English wheat. In general, it appears to be less evident than in barley, though from our own observations it follows a similar course. During the past season, we have been fortunate enough to obtain from Rothamsted Experimental Station samples of both Als and Vilmorin wheats during seven weeks covering a period immediately prior to and following upon the cutting of the crop. Many grains of the earliest samples when first removed from the ear and planted showed rapid germination, a capacity which they lost almost entirely after a short period of drying in the sun. The later samples of wheat showed pronounced dormancy but with gradually increasing recovery which was almost complete in the last sample. By this time grain from the first sample, which had been stored air-dry in the laboratory, had also matured. It is clear that the tendency of grain to sprout during harvest will depend not only on the atmospheric conditions but also on its state of dormancy. When hot dry weather, which will hasten maturation, is followed by rain, conditions are most favourable for sprouting; in a cold damp season grain is likely to show less tendency to sprout in a rainy harvest. It must, however, be realized that if favourable conditions prevail for a sufficiently lengthy period, even very dormant grain will eventually germinate unless some external agency such as mould intervenes to make an end.

During the past harvest season, we have been able to carry out a preliminary investigation on the degree of resistance to sprouting exhibited by several varieties of wheat. By the kindness of Mr. H. W. Gardner, Hertfordshire Agricultural Institute, we were able to examine samples of nine wheat varieties grown, with and without nitrogenous supplement, side by side on three different sites selected for differences of soil condition. On the first of these sites the crop had been cut, stooked and carried in good weather and had escaped sprouting. On the other two, harvest conditions had been by no means so good, wet weather causing a degree of sprouting in several instances. Weight percentages of sprouted grain separated by the hand-picking of sub-samples weighing not less than 80 gm. are set out in the following table.

Variety	Percentage sprouted grain Site II No nitrogen	 Site II Nitrogen added	 Site III No nitrogen	 Site III Nitrogen added
Holdfast	39·7	24·4	27·1	26·8
Steadfast	42·6	48·6	34·0	19·9
Juliana	30·1	25·8	7·8	12·2
Squarehead's Master	18·1	16·7	4·1	1·6
Scandia	17·6	7·3	4·2	2·3
Weibull's Standard	3·8	8·4	1·0	1·2
Desprez 80	19·7	23·0	1·7*	0·5*
Vilmorin 27	2·9	0·9	4·1	6·1
Little Joss	6·1	6·4	2·6	4·0
Total average	20·05	17·95	9·6	8·3

* Desprez 80 from Site III was immature and thus very dormant, as with unripe grain after sun-drying. Results for Site II are probably a truer indication of the tendency of this variety to sprout.

These results indicate, as might be expected, that nitrogenous manuring has no substantial influence on the dormancy period of wheat, the small differences shown in the table being probably adventitious. On the other hand, as between varieties, Holdfast, Steadfast and Juliana seem especially prone to sprout, a tendency accentuated on Site II where harvest conditions were even more severe than on Site III. Squarehead's Master seems to occupy an intermediate position, while Little Joss, Weibull's Standard and Vilmorin 27 appear to be much more resistant. This conclusion has been to some extent confirmed by the examination of isolated individual samples from other sources, which suggest that while soft white wheats such as Wilma and White Victor sprout readily, Als, Atle, Iron II, Redman, 60 and Bersée are resistant.

Further confirmation of some of our findings has been communicated privately to us by Dr. Hunter, of the National Institute of Agricultural Botany, who has noted that during the harvest of 1944 sprouting trouble was especially prevalent in Holdfast, Steadfast and Juliana.

It has to be admitted that our data are at present insufficient to decide as between varieties on their relative dormancy periods. It is hoped, however, to obtain such information during the next season. In considering the preliminary data, it has to be remembered that all varieties were reaped and carried at the same times, and hence the earlier ripening varieties have been exposed to a more severe test. As regards breadmaking quality, it is disconcerting to find that the majority of the resistant wheats are generally thought to be poor. On the other hand, it has recently been suggested by Johnston[5,6], and by Harrington and Knowles[7] that dormancy may be an inherited character. If such be true, it should offer possibilities to the plant breeder, and in fact, in the case of barley, Freistedt[8] has already directed attention to this.

The general problem would appear to be one of some importance if we continue to grow wheat in Britain for bread-making.

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UNIVERSITY REFORM IN BRITAIN

By Dr. RAYMOND PRIESTLEY
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UNIVERSITY reform is in the air to-day. The amount of discussion about the future of higher education that is going on among thinking people—and to-day a greater proportion of citizens are thinking than usual—cannot but do good. Isolationism—the 'ivory tower' conception of the role of the university—has always been liable to become a limiting factor in its usefulness.

The National Union of Students has recently discussed the subject, and has issued a report*, the chief characteristic of which is its entire reasonableness. One somehow expects student opinion to run to extremes, usually to the Left. It would indeed be unnatural if youth were satisfied with the present condition of affairs. But all the suggestions put forward here are in my own opinion worthy of thoughtful consideration by university authorities.

Here, as elsewhere, the abolition of fees tends to become a fetish or King Charles' Head. Education for all who are worthy to the limit of their need and powers is a first-rate end; but I do not believe that, in our present state of society, abolition of fees is the best means to that end. Nor is it likely to be for some time. There are very many people to-day who can afford to pay for their university career. Many find pride in doing so. Unless we drastically change our methods of selection—getting away from the purely intellectual sieve—we should, if we exclude fee-paying students, lose a valuable element of student life. Oxford and Cambridge in particular have benefited from the leavening influence of many men who would not have reached a university on intellectual qualifications alone, and no one has benefited more from their presence than the scholars themselves.

Also, while our society is so constituted that men exercise influence more than the average through accident of birth and wealth, it is good that they should, as part of their education, live in a university atmosphere for some years. Again, government is not yet so conditioned that the universities would not be financially crippled if fees were eliminated from their income. First we need the Government and local authority grants doubled and doubled again. I am therefore against the abolition of university fees. The time is not nearly ripe. What would be the value of flooding impoverished universities with students for whom we cannot cater properly, while excluding men and women all of whom to-day have to prove their intellectual fitness for university education through entrance examination; many of whom select themselves on other grounds better than some scholars, and most of whom, as society is organized to-day, are going to play an important part, and should have the best possible preparation. The abolition of fees in universities might be a proper and necessary feature of a social revolution; but as an incident of university organization to-day it is premature and out of place. Let us, on the other hand, have more generous maintenance allowances and more scholarships. Most of our anticipated expansion in numbers should derive from that source.

* The Future of University and Higher Education: a Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp. 16. (3 Endsleigh Street, London, W.C.1, 1945.) 6*d*.

The need for, and value of, a high standard of character and personality as well as intellect in university personnel—be they staff or students—make the more important one recommendation that I can heartily endorse: compulsory residence for one year at least. I would go further and ask for two as a minimum. It is a debatable point whether, if only one is required, the freshman year is the best. Different colleges at Oxford and Cambridge hold different views about this.

An interesting point raised is the question of student representation on university governing bodies At the University of Birmingham students are represented on the Court. This is a good thing, but it means very little in practice At the University of Melbourne they are represented on the Council. That was never an embarrassment to the University during my tenure of the vice-chancellorship, and I do not believe it had been before. What the National Union of Students means by direct access to council, senate and faculties is not clear; but I do not believe any such body would refuse to see a deputation of students if asked, certainly not in any university on the staff of which I have served. I agree, however, with the Union that the most promising method of integration is through staff-student committees. I think few heads of departments, if properly approached, would refuse to participate in such discussion groups. A good example of this sort of co-operation is the Arts Council at the University of Birmingham.

The revolt against over-lecturing is natural, but can, I think, be overdone. Spoon-feeding would be as bad as under-nourishment. Let us have more seminars and informal tuition by all means. I have tried out the cyclostyled notes idea, and on the whole it was not a success. It was useful occasionally for broadcasting diagrams or charts, or especially difficult arguments; but used as a general rule it made for slackness and inattention, at least in some subjects and with certain types of students. I can imagine, however, that the issue of regular notes might be valuable in certain subjects. Personally, I would rather have students stay away and read than be compelled to attend lectures in which they are not interested. In this, as in many other things, however, a vice-chancellor carries less weight than professors, and he must defer to their specialist knowledge of teaching.

For the rest, a vigorous student union, as autonomously governed as possible, is an essential requisite for satisfactory life in the non-residential university. The sad thing to-day is the fact that the educative influence of the union is confined to a minority of students. The majority use the building only as a restaurant, lounge and dance hall. Only student opinion and student influence can remedy this. Many never go near the union at all. They are the 'brown baggers' of whom we hear so much. The only answer to them is compulsory residence in halls of residence generously equipped with a staff whose interests are student-centred, and with the amenities that foster community spirit and social activity.

I would agree with the estimate that student numbers in British universities should be increased over all by 50 per cent; though, since Oxford and Cambridge are near saturation point, this will mean doubling the size or number of the provincial universities. The remarks made about the curriculum are well worth study by university senates, which are, indeed, not unaware of the need for reform.

Many faculties are vigorously discussing these questions now.

Nearly all the proposals in what is a useful and provocative little booklet mean greater expenditure. We must hope that those who hold the purse-strings will realize that to-day the universities are a long way behind scratch. The greater part of the first increases of grant will be expended in bringing us back into line for a good start after the backsliding made inevitable by six years of war.

It has been difficult to review the report issued by the National Union of Students in a short article ; it is quite impossible to do justice to the many subjects touched upon at the Second Educational Conference of the Association of Allied Professors and Lecturers, held in London on April 14, 1944, the proceedings of which are now available*. Mental indigestion and a seething mind are inescapable after a first reading There are, however, some impressions that pick themselves out. The modern Soviet university seems to have got farthest from the 'ivory tower' idea, but this has been incidental to profound social and political changes. Unless we are prepared to follow them in the larger field—and I for one think that we should lose more than we should gain by doing so—we must seek to attain the same end by more devious ways The United States are trying hard to achieve an educated democracy and have had a measure of success. It has been easier in a country with an expanding frontier than it has been in overcrowded Western Europe with its bounds set by history and tradition. It will be less easy in the America of the future, when the expanding frontier will be a memory of the past. When I visited the United States in 1936, the Federal Government was spending sixty million dollars a year on student maintenance, because it was becoming progressively more difficult to work one's way through college in competition with the regular labour force.

I like Sir Fred Clarke's definition of training as "the cutting edge that makes education specifically serviceable" General acceptance might give the word and idea a new lease of respectable and useful life Interchange on the Francqui chair scale, with its fully equipped laboratory and specialist assistants for the visiting professor, approaches the ideal, and is linked in my mind with the good idea of occasional interchange between the professor and master of the school sixth form The greatest professors like taking elementary classes despite what Bruce Truscott says. It is not too great a step to go back to school, though the step would certainly be new. The American system of sabbatical leave and the junior's *wanderjahr* have done much for peaceful penetration into China, and the British Commonwealth might well emulate their trans-Atlantic cousins here. Of the great university dangers, 'specialization, mechanization of learning, and interference by the State', we in Britain know something of the first two, but we have steered clear of the third thanks to our genius for anomalies in our government set-up Long may that remain true.

Sir Ernest Barker has likened the ancient universities to mountains of ice nine-tenths submerged in seas of history and tradition Having had experience of Antarctic exploration, I am tempted to carry the analogy a step further. The new universities are more like the snowbergs from the Antarctic continent with half their bulk above water. They may have a more workmanlike façade, if a different one. They are without the peaks and pinnacles, but there is something to be said for a solid rectangular shape. They are more responsive to the winds of public opinion. They are more readily adaptable to the social environment in which they are set. These are on balance, not bad characteristics. I will not press the analogy too far, for icebergs and snowbergs alike, when they grow older, pass through the stage of being hidden dangers to navigation, and finally they disappear leaving no trace.

* Association of University Professors and Lecturers of the Allied Countries in Great Britain. Second Education Conference, April 15, 1944 Some Comparisons between Universities Pp. xvi+64 (Oxford Basil Blackwell, 1944) 2*s*. 6*d* net

NEW FELLOWS OF THE ROYAL SOCIETY

THE following were elected fellows of the Royal Society on March 14 :

MR. L. COLEBROOK, a member of the scientific staff of the Medical Research Council. Distinguished in the application of bacteriology to clinical medicine, he played a leading part in the practical establishment of the 'sulpha' drugs, and has thrown much light on the fevers of childbirth. During the War he has directed important investigations on burns.

MR. W. S. FARREN, aeronautical engineer, director of the Royal Aircraft Establishment, Farnborough. He has been associated with aeronautical research and development continuously since 1914, and has contributed greatly to advances in the science and practice of aeronautics.

DR. N. FEATHER, lecturer in physics in the University of Cambridge ; distinguished for investigations which have added much to knowledge of the spontaneous and induced disintegrations of atomic nuclei.

PROF. J. H. GADDUM, professor of pharmacology in the University of Edinburgh ; distinguished for his work on the identification and estimation of acetylcholine, adrenaline and histamine in animal tissues and for his experimental contributions to the conception of cholinergic and adrenergic nerves.

DR. H. GODWIN, lecturer in botany in the University of Cambridge ; distinguished as a plant ecologist, and especially for his contributions to the knowledge of the post-glacial history of British vegetation based on the pollen analysis of recent deposits.

PROF. J. M GULLAND, Sir Jesse Boot professor of chemistry, University College, Nottingham ; distinguished for his analytical and synthetic work in the phenanthrene group of alkaloids, and for his work in the development of the chemistry of substances of biological importance.

MR. H. W. HARVEY, marine biologist ; distinguished for his contributions to our knowledge of the 'productivity of the sea' by co-ordinating the varied factors, physical, chemical and biological, which determine it.

PROF. V. C ILLING, professor of oil technology in the Imperial College of Science and Technology ; distinguished for his researches on the relation of texture of sediments to oil accumulation, and for

refinements of stratigraphical and geophysical methods applied to interpret the structure of oil-bearing lands.

MR. A. E INGHAM, University lecturer in mathematics in the University of Cambridge ; distinguished for his researches in pure mathematics, particularly in the theory of numbers

PROF H. D. KAY, director of the National Institute for Research in Dairying, distinguished for his biochemical work, particularly for his investigations upon organic phosphorus compounds and the phosphatases Recently he has applied his methods to the practical problems of dairying

DR W B. LEWIS, lecturer in physics in the University of Cambridge, distinguished both for his contributions to the investigation of the structure of atomic nuclei and also to the development of the science of electronics, with special relation to ultra-high frequency radiation.

DR. KATHLEEN LONSDALE, physicist, Royal Institution ; distinguished for outstanding contributions to the investigation of the crystalline structure of organic compounds by means of X-ray analysis. Particularly important have been her recent researches into the fundamental mechanics of crystal structure.

PROF. P C. MAHALANOBIS, professor of physics, Presidency College, Calcutta, and founder of the Statistical Laboratory, Calcutta, distinguished for his contributions both to statistical theory and to the applications of statistics, particularly to sample surveys, agriculture and population.

PROF. R. E. PEIERLS, professor of applied mathematics in the University of Birmingham ; distinguished for his contributions to theoretical physics, particularly in the application of quantum mechanics to the electron theory of metals and other phenomena of the solid state, and in the theory of the atomic nucleus.

PROF. J MONTEATH ROBERTSON, Gardiner professor of chemistry in the University of Glasgow, distinguished for his work on crystal structure by the methods of X-ray analysis. He has made measurements of great accuracy in this field, and has derived from them precise molecular structures, electron density distributions, and inter-atomic distances of organic molecules.

PROF F. M ROWE, professor of colour chemistry and dyeing in the University of Leeds. As leading dyestuff technologist, his work has been of national importance. He has made varied and original contributions to the chemistry of dyes and intermediates.

SIR WILLIAM WRIGHT SMITH, King's botanist in Scotland, regius keeper of the Royal Botanic Garden, Edinburgh, and regius keeper of botany in the University of Edinburgh ; distinguished for his contributions to the taxonomy of Angiosperms, and especially for his monographic treatment of the genera *Primula* and *Rhododendron*

MARJORY STEPHENSON, a member of the scientific staff of the Medical Research Council, distinguished for her biochemical researches upon the metabolism of bacteria, which, with those of her pupils during twenty-five years, have included work upon hydrogenase, lactic dehydrogenase and adaptive enzymes.

MR B. N. WALLIS, mechanical engineer, chief of research and development of Vickers-Armstrong Ltd., Aircraft Section. He has been responsible for many new projects of design, and his work has led to secret developments which have been of great importance in the war effort.

MR J. Z. YOUNG, lecturer in zoology in the University of Oxford, distinguished for his outstanding contributions to knowledge of the nerve fibre, both of its structure and function During the War he has worked on important clinical aspects of the repair of damaged nerves.

NEWS and VIEWS

Prof. Guido Castelnuovo

MATHEMATICIANS will be pleased to learn that Prof. Guido Castelnuovo, formerly professor of geometry in the University of Rome, is safe and well In a recent letter to Mr. L. Roth, of the Imperial College of Science and Technology, London, he relates that he, with members of his family, obtained refuge during the German occupation of Rome, and that he has now returned to his well-known house in the Via Boncompagni. Castelnuovo is eighty years old this year ; the world of science will unite in congratulation. Castelnuovo's work (which was reviewed in *Nature* of December 10, 1938, p. 1016) represents the best in Italian geometrical thought over a long period. Born in an age which, to quote his own phrase, "closed one epoch and opened another", his first papers were, naturally enough, on the projective geometry of higher space. But soon, with Corrado Segre, he was making essential contributions to the algebraic geometry of curves which, sixty years ago, was beginning to assume its modern form. Then, in 1894, with Federigo Enriques as his collaborator, he initiated the study of the algebraic geometry of surfaces, on no firmer a foundation than the hints and conjectures (some of them mistaken) of Max Noether. Much of this work is definitive, in a negative as well as in a positive sense, for where he has paused, his successors in the field have often found it impossible to progress. Perhaps the most celebrated of Castelnuovo's papers is the memoir of 1896, in which he gives necessary and sufficient conditions for the rationality of a surface, that is, for the existence of a one-to-one algebraic correspondence between the points of the surface and those of a plane. Incidentally, this was quite literally a piece of research, in that the author did not suspect what the conditions were before he began to write the paper. So the theory of rational surfaces was able to take its place by the side of the classical theory of rational curves.

Already (and, in fact, during the previous ten years), Italian geometers were posing similar questions for the threefold, that is, the locus which is represented analytically by an equation in four co-ordinates. The quadric threefold, like the quadric surface, is easily seen to be rational by projecting the locus from a point of itself. It was also well known (though the proof is less obvious) that the general cubic surface is rational. The question now arose, what could be said about the general cubic threefold ? The question was destined to become one of the historic problems of geometry. At first glance one could see that the answer would either be imme-

diate or else very difficult to obtain A first attempt fell wide of the mark: Segre, in his great work on cubic threefolds, written about 1887, had tried to grapple with the problem, but it turned out that the varieties he considered, though rational, were not general of their type. The problem was then taken up by Prof. Gino Fano, of Turin, one of Castelnuovo's first pupils In a struggle which has lasted some fifty years, Fano has made vital contributions to the subject, culminating last year with the news, in a letter from Switzerland, that he had succeeded in showing that the general cubic threefold is irrational. It would be an under-statement to say that geometers await with impatience the appearance of Fano's investigation.

Miss P. M. Taylor

MISS P. M. TAYLOR, who has recently been appointed woman educational officer to the Central Council for Health Education, was educated at Girton College, Cambridge, and Westfield College, London Miss Taylor joined the executive committee of the Association of Women Science Teachers in 1932, and in 1935 was elected honorary general secretary, in which capacity she served until October 1944. Her new position with the Central Council is an important one which necessitated her relinquishing the onerous duties of the general secretaryship of the A.S.W.T., though she was re-elected to the Executive Committee this year. The present investigations of the Association, which have already resulted in the publication of the pamphlet "Pre-Nursing Course in Schools" (1943) and the Interim Report on Science in Post-Primary Education (1944), are in a large measure due to the initiative and exceptional powers of organization of Miss Taylor. The Association is fortunate in having her continued co-operation in the completion of this work, the results of which it is hoped to publish shortly. Miss Taylor's zeal is unabated, in spite of the calls made upon her and her capable assistants during the war years to keep in touch with the members. Their success is seen in the vigorous growth in membership and the wide-spread interest in progressive methods of science teaching, which factors have necessitated the appointment of a full-time secretary. In addition to her work as honorary general secretary, Miss Taylor has served on the Education Advisory Committee of the Central Council for Health Education, the Consultative Committee to the Nursing Reconstruction Committee, Royal College of Nursing, and as president of the Essex Branch of the A.W.S.T. She held the post of senior science mistress at the Southend-on-Sea High School for Girls until July 1944.

Agricultural Zoology in Scotland

DR. D. S. MACLAGAN, lecturer in zoology at King's College, University of Durham, has been appointed head of the Department of Zoology of the West of Scotland College of Agriculture, Glasgow, and research advisory officer in agricultural zoology for the south-west of Scotland, in succession to Prof. L. A. L. King, who has retired. Dr. MacLagan held a Ministry of Agriculture research scholarship during which he carried out work at the Parasite Laboratory of the Imperial Bureau of Entomology and at Harvard University, and later worked with a Carnegie research fellowship at the University of Edinburgh. He is known for his work in animal ecology and on the dynamics of animal populations.

Cosmic Ray Investigations in Armenia

THE preliminary results of the Alagez Expedition of 1944 for the study of cosmic rays have been published in the U.S.S.R Observations have been made each year since 1942 from a camp on Mt. Alagez in Armenia, at a height of about 10,000 ft. above sea-level. All instruments, supplies and camp equipment had to be carried on pack animals. As conditions are extremely favourable for the study of cosmic rays, it has now been decided to build a permanent station there, with an observation post at about 13,000 ft. It is now believed that cosmic rays contain a third element in addition to mesotrons and electrons. The particles which make up this third element have a greater ionizing effect on air than either mesotrons or electrons The latest expedition spent three months in attempting to discover the nature of this third component, especially the mass of the particles of which it is composed. The difficulty was to separate them from the other already known components. New methods were evolved, and some new and extremely sensitive instruments built. The particles were found to have properties very similar to those of protons The part they play is apparently more significant than was at first realized. Only preliminary data, however, have been obtained, and the material is still being studied. The expedition made several thousand observations during great cosmic ray showers for the purpose of determining the energy of the cosmic particles which cause the showers. It was found to be enormous. A special kind of shower, occurring over a very small area, but including a tremendous number of particles, was also discovered.

Stone Age Implements in India

INDIA is rich in relics of Stone Age man, and the prehistorian there has a wide field for research. Not a great deal of new information will be gleaned from "Pre- and Proto-history of Gujarat" (H. D. Sankalia, reprinted from "The Glory that was Gūrjaradesa", 1943), though the gazetteer of finds at the end of the article is useful so far as it goes. What the prehistorian asks from researchers in the field in India is definite stratigraphical data. Perhaps, therefore, the geological section of the right bank of the Sabarmati River at Pedhāmli appearing on p. 15 is the most important single item in the article. It would seem that, as throughout Madras, early Stone Age artefacts come from a gravel conglomerate which rests immediately upon laterite. The occurrence of a microlithic industry suggests that its makers were using composite tools in which several 'pigmy' flints were hafted together to form one efficient instrument. Such industries appear at various different periods when natural circumstances permit or encourage their development and may be of widely different ages; and one must enter a caveat against the wisdom of trying to correlate the microlithic finds of Gujarat with those of Europe. In India itself, Colonel Gordon, in "Indian Art and Letters" (1936), has shown that the rock-shelter paintings in the Mahadeo Hills are not very old—maybe first century B.C. to tenth century A.D. in date. There the only industries found in the rock-shelters below the paintings consist of typical Indian pigmy artefacts. Near the surface a little pottery occurs; in lower levels this is absent. The conclusion would seem to be that the pigmy industries themselves are not very old and certainly nothing to do with the European Mesolithic either culturally or in time. This is also true of the numerous

microlithic industries in quartz found in Ceylon. Dr. Sankalia ("The Second Gujarat Prehistoric Expedition A Preliminary Account of the Search of 'Microlithic Man in Gujarat'," by H. D. Sankalia and I. Karve, *New Indian Antiquity*, 7, No. 1, April 1944) has described the unearthing of some skeletons, believed to belong to the folk who made the pigmy objects described. Physical anthropologists will naturally await with interest a complete account of these finds when the final study of them has been made

Community Centres

The report on community centres recently prepared by the Ministry of Education (Pp. 40. London. H.M. Stationery Office. 9*d*. net) is a document of much importance. The Government has decided that the provision of such centres to promote the social and physical training and recreation of the community should be regarded as coming within the scope of the education service administered by local education authorities, such provision being covered by Section 53 of the Education Act, 1944, without prejudice to the power of other local education authorities under Section 4 of the Physical Training and Recreation Act, 1937, to provide centres for athletic, social or educational objects. Arising out of that decision, this report has been prepared at the instance of the Minister of Education by some of his officers, and is now published for general information. The first chapter of the report goes at once to the root of the matter. "During the present century, the day-to-day life of the British people has been profoundly affected by two parallel and closely related developments—the mechanisation of industry and a progressive reduction in working hours. The reduction in working hours may have been largely due to the growing demand for more leisure, but it was mechanisation which made it possible to meet the demand". That is the point of departure taken in this searching and comprehensive report; that, and another fact plain to be seen, that it is one thing to have spare time and another to know how to use it wisely. Though the report does not expressly say so, it means that we have reached a position in which the twofold distinction between work and leisure should be replaced by a threefold distinction between (1) work, done for a living, whether one likes it or not, (2) relaxation, play, recreation, for the recovery of poise, and (3) true leisure, spent upon pursuits which may make it in one way or another "the growing time of the spirit". In subsequent chapters the report goes into detail about the organization, staffing, provision and maintenance, and ownership, control and management of community centres A valuable appendix sets forth the suggested accommodation required for neighbourhood units in varying situations.

Control of Rabies

In an interesting leading article, the *Lancet* (628, Nov. 11, 1944) directed attention to the need for the existing regulations designed to prevent the reintroduction of rabies into Great Britain. The law requires that all dogs imported, by air or otherwise, shall be quarantined for six months; strict insistence on this regulation would prevent the reappearance in Britain of this serious disease. Rabies is primarily a disease of dogs, cats and allied species; but it is communicable to man and to domesticated animals by the bite of a 'mad' dog. It was first recorded in Great Britain in A.D. 1000, but it probably existed here before that date. In the middle of the eighteenth century it raged among dogs in London and elsewhere. In the nineteenth century it broke out among several packs of fox-hounds, and some thirty-six persons a year died of rabies. By 1902 rabies had been eradicated from Great Britain by stringent control measures, and it did not reappear for sixteen years. By then (see Stockman, S., *Vet Record*, 32, 135; 1929, quoted by the *Lancet*, *loc cit.*) the public was so unfamiliar with the disease that some sections of it failed to realize the dangers of its reintroduction, and the abnormal conditions of that time doubtless helped its spread.

Rabies was found among dogs in Great Britain in September 1918, the infection having been brought in by smuggling dogs into the country by air. The Ministry of Agriculture took energetic measures against it, and these measures were helped by the fact that most of the dogs were affected by the dumb or paralytic form of the disease, which greatly restricts their wanderings and ability to bite, and also by the fact that the disease broke out in Cornwall, which is isolated to some extent from the rest of England; most of the affected dogs wandered west to the sea. Nevertheless, some seventeen counties became involved, 327 dogs died of the disease and 368 human beings were bitten and had to be treated. The outbreak was not controlled until December 1921 (see *Lancet*, ii, 719; 1926). In the United States, during the last ten years, there has been an average of fifty-seven cases a year, and some States have recorded more than a thousand cases a year among animals. Rabies vaccines are available, and the *Lancet* (628, Nov. 11, 1944) discusses the value of these, which has been questioned. Meanwhile it cannot be too widely known that rabies will, if it comes again to Great Britain, cause much suffering among men and animals. The quarantine regulations, which can keep rabies out of the country, should therefore be vigorously supported

Stars or Planets?

Peter van de Kamp has an article with this title in *Sky and Telescope* of December 1944, in which he deals with the question of the criterion for stars and planets—a matter of considerable importance in view of the fact that recent discoveries have shown the existence of 'planets' fifteen or twenty times the mass of Jupiter. He accepts Russell's critical value of 1/20 of the sun's mass as a conventional borderline between visible stars and the invisible bodies which can be designated as 'planets'. This criterion defines a planet or star, therefore, by its mass, not by its size. Among the methods for detecting unseen companions of low mass is the photographic method applied to nearby stars, and if the determination of the orientation of the perturbation orbit were sufficiently accurate, good results would be obtained. Difficulties arise from the fact that photographic star images are 1″–3″ in diameter, and most of the recently discovered perturbations have a total amplitude of less than 0·1″. The gravitational method for discovering faint companions of low mass, while it is more powerful than the direct visual approach, has decided limitations for very low masses, and it would be extremely difficult by this method to find companion masses less than 1/100 times the sun's mass, even for the nearest stars. The star which seems unattended by dark companions may be the exception, and it is possible that the stars attended by massive companions, rather than by small planets,

are in the decided majority Our solar system may prove to be an extreme type of system, rather than an average type Though generously endowed with planets, the sun is the only star known that has no close companion star.

Optical Phenomena in the Atmosphere

L/Cpl. V. S. Taylor, 6 Field Park Coy., R E., C.M.F., writes: "The discussion on optical phenomena in the atmosphere in *Nature* of December 9, 1944, brings to mind an occurrence frequently witnessed at Anzio while it was a beachhead. During, and immediately after, intense A A. fire under conditions of virtually clear sky, with the sun behind the observer, concentrically disposed wave ripple arcs could be seen passing away from the barrage zone, in the portion of the sky about 45° forward of the observer. The acute compression of the atmosphere peripheral to the bursting shells caused the compression zones to be sufficiently altered in refractive index to produce an optically visible phenomenon when refracting undiffused sunlight' This phenomena would seem to be similar to the concentric waves observed by Dr A H Goldie following a bomb burst (*Nature*, **154**, 738; 1944).

Post-War Bread in Britain

The Ministry of Food, in collaboration with the Health and other Departments interested, has arranged a conference with the industrial and trade organizations principally concerned with post-war bread. It is hoped that the discussions of the conference will assist the Departments in advising Ministers on post-war flour and bread policy and in particular on any regulations which may have to be made after war-time control ends. The milling and baking industries, the flour importing trade and the co-operative movement have been asked to nominate representatives to the conference, invitations will be addressed to other interests later as may be necessary The conference will be attended by the Lord Horder (personal adviser to the Minister of Food on medical aspects of food problems), Sir Jack Drummond (scientific adviser to the Ministry of Food), Sir Wilson Jameson (chief medical officer of the Ministry of Health), Dr. Andrew Davidson (chief medical officer for the Department of Health for Scotland) and Sir Edward Mellanby (secretary of the Medical Research Council). In addition, there will be present administrative officers representing the Ministry of Food, the Ministry of Agriculture and Fisheries and the Ministry of Health. Sir Henry French, the permanent secretary of the Ministry of Food, will be the chairman of the conference.

Agricultural Scholarships

The Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at university departments of agriculture, or agricultural colleges, for degree or diploma courses in an agricultural subject; or at veterinary colleges for courses in veterinary science; and for six extended junior scholarships (for those who have already held junior awards), and sixty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding a year, in agriculture, horticulture, dairying or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers, and to persons who are themselves *bona fide* workers in agriculture. The value of the awards is such that neither the recipients nor their parents are normally required to make any contribution towards the cost of the training provided The usual method of selection is by interview. Full information concerning the scheme and forms of application may be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W 1, or from the offices of County Councils. The latest date for submitting applications is April 30, 1945

The Night Sky in April

New moon occurs on April 12d 12h 29m U.T., and full moon on April 27d 10h 33m The following conjunctions with the moon take place: April 9d 19h, Mars 3° N, April 17d 13h, Saturn 0 1 N, April 23d. 06h, Jupiter 3° S; April 26d 18h, Mercury 6 3° S Only one occultation of a star brighter than magnitude 6 takes place in April, namely, 8 Leon., which disappears on April 21d 1h. 29 7m Mercury sets at 20h. 11m at the beginning of April and rises at 4h 10m at the end of the month, about 25 minutes before sunrise. The planet is in inferior conjunction on April 13 and is stationary on April 3 and 25. Venus is a conspicuous object in the western sky in the early portion of the month, setting at 21h. on April 1. On April 30 the planet rises at 3h. 35m, an hour before sunrise. Venus is in inferior conjunction on April 15. Jupiter is visible throughout most of the night, setting at 5h 13m. and 3h. 14m at the beginning and end of the month, respectively. Saturn can be seen in the early portion of the night, setting at 1h. 49m. and just after midnight at the beginning and end of the month, respectively. The Lyrid meteors are active during April 18–22, but moonlight will interfere with the observation of the shower.

Announcements

We regret to record the death on March 23 of Sir Napier Shaw, F.R.S., the doyen of British meteorologists, aged ninety-one

Botanists will be pleased to learn that Mr. E. J H. Corner, assistant director of the Botanical Gardens, Singapore, who has been in the hands of the Japanese since the fall of Malaya is, according to a cable received from him, "well, happy, working as a botanist".

Dr. Thomas A. Jaggar, the well-known volcanologist, has been awarded the Franklin L. Burr Prize of 1,000 dollars by the National Geographic Society. The Prize, established under a bequest of the late Mary C. Burr of Hartford, Connecticut, provides for cash prizes to members of the Society's expeditions considered to have done especially meritorious work in the field of geographical science. The award was made to Dr. Jaggar for his part in the development of an amphibian mobile boat in 1927, which was used by a National Geographic Society expedition headed by Dr. Jaggar to carry on researches in Alaska in the region of Pavlof Volcano during 1927–28.

A course of twelve lectures in special librarianship has been arranged by the Association of Special Libraries and Information Bureaux, and will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C 1, at weekly intervals starting on April 18, at 4.30 p.m. Applications to attend should be sent to the General Secretary, ASLIB, 52 Bloomsbury Street, W.C 1, as soon as possible; the fee is £5 5*s*. for the course.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Age of the South African Ape-men

THE determination of the age of mammalian fossils of the later Tertiaries is a matter of the greatest difficulty. In America, Pliocene land beds are rather rare, and except in Europe where we can divide the Pleistocene by its Ice Ages, the classification of the Pleistocene is also very difficult. We have had many different views of the ages of the Siwalik deposits by Falconer, Lydekker, Pilgrim and Matthew. In South Africa we are in much greater difficulty as the majority of our mammalian fossils are not nearly related to those of Europe or Asia, and are even less related to those of America

The determination of the age of the caves which have yielded the skulls and remains of the Australopithecines or ape-men is a matter of very great importance, as these Primate fossils show remarkable affinities to man. If they are Pleistocene they were contemporaries of man, though probably survivors from a family from which man arose in the Pliocene If they are Pliocene they may be nearly related to the ancestor of man, and *Australopithecus* — the Taungs ape-man—may be so near to ancestral man as to be practically the 'missing link'.

At Kromdraai true horse (*Equus*) teeth are abundant. There is a large horse and a small one, so we may consider the Kromdraai ape-man *Paranthropus* as belonging to some part of the Pleistocene

The Sterkfontein ape-man *Plesianthropus* is certainly of a very different age. No species of mammal is known from both Sterkfontein and Kromdraai except perhaps two species of the rats of the genera *Mystromys* and *Otomys*. The 'baboons' are different, the jackals are different, and so are the dassies. Further, no horse teeth are known from the Sterkfontein cave. though they have been found only 150 yards away. As a porcupine occurs which does not seem to differ from the living species, I thought it safer to keep *Plesianthropus* in the Pleistocene, though the presence in the cave of two species of sabre-tooth cats seemed to point to the deposit being old; but there was always the possibility of sabre-tooths surviving into Pleistocene in South Africa after they had died out in Europe and Asia.

The Taungs ape is manifestly much older than those others. The associated fauna is quite unlike that at Sterkfontein or Kromdraai. I, therefore, provisionally placed the Sterkfontein and the Kromdraai ape-men in Middle Pleistocene, and the Taungs ape-man in Lower Pleistocene, though not improbably belonging to Upper Pliocene.

I have just had given me a few days ago by the Abbé Breuil the snout of a primitive hyæna. This was found by Dr. H. K. Silberberg at Sterkfontein three years ago. I have seen Dr. Silberberg and find that he picked up the specimen in the lower part of the Sterkfontein cave. The spot is almost directly below that in which the *Plesianthropus* type skull was found; but at about 60 ft lower level. The fossils which I have collected at this lower level appear to be similar to those above

We already knew a species of *Crocuta* from Kromdraai very closely allied to the European *Crocuta spelœa,* and from some part of Sterkfontein a jaw of *Hyœna hyœna,* and from the main Sterkfontein cave portions of a hyæna with the crowns of the teeth hopelessly broken. The hyæna discovered by Dr. Silberberg is a Pliocene type which must, I think, be placed in the genus *Lycyœna*. *Lycyœna* is a primitive genus found in the Lower and Middle Pliocene of Europe and India While there is a possibility of the Pliocene *Hyœna* surviving into Pleistocene with the sabre-tooth cats, it now seems more likely that the Sterkfontein cave is Pliocene;

DENTITION OF *Lycyœna silberbergi* BROOM. NAT SIZE.

and if so we must put the other caves to an earlier date also.

The Kromdraai skull we may put as probably Lower Pleistocene, and the Sterkfontein as probably Upper Pliocene. The Taungs skull, which must be much older, we may assign to the Lower part of the Upper Pliocene or even to Middle Pliocene. Of course, it will be readily understood that the difficulties are great, and the evidence very little. The director of the South African Geological Survey, Dr. A. W. Rogers, said in 1925 that "there was no probability of the age of the (Taungs) deposit being determined", and so far as I know no geologist has ever made any attempt to solve the difficulty. Still, some attempt must be made. So much hangs on it.

If the Taungs ape-man is of Pliocene, and possibly even Middle Pliocene, age it may again assert its claim to be very near to man's ancestor. Its teeth are practically identical with those of some Bushmen.

A full account of all we know of the South African ape-men has been prepared by Dr. G. W H. Schepers and myself, and it is hoped that this work will be published this year.

R. BROOM.

Transvaal Museum,
Pretoria
Jan 27.

Index of Diversity as Applied to Ecological Problems

IN Research Items in *Nature* of December 30, p. 833, attention is directed to Dr. C. B. Williams' recent paper[1] in which he applies the 'index of diversity' (α) to populations of various kinds. He claims that α is a property of the population, and is independent of sample size. He attempts to use it for the relation between numbers of species and size of sample in samples of plant populations obtained by means of quadrats, and in using some figures of Gleason's implies that, given a random distribution of quadrats, the application of α would be valid.

It is difficult to test these assumptions directly, since it is usually impossible to count individuals of plants, and therefore impossible to obtain the relation between numbers of species and numbers of individuals. Recently, while engaged on work for the Forestry Commission, I obtained figures for the composition of various kinds of heath vegetation, using quadrats of different sizes. The figures obtained show that the index of diversity varied both with the way in which the quadrats were distributed (random or otherwise) and with the quadrat size. Thus α obtained by using quadrats of 1/8 square metre (quadrats being grouped together to give the varying sample sizes) was about 7, while α derived from counts of the mean numbers of species in quadrats of three different sizes (1/20, 1/8 and 1 square metre) was about 1·2. In the case of a piece of old *Calluna* heath in which there were only six species of flowering plant, 76 per cent of the cover being provided by *Calluna*, while *Empetrum nigrum* and *Vaccinium myrtillus* formed the remainder, the calculated number of individuals expected from Williams' formula was 3,000 per square metre. The actual number was not recorded, but the calculated number is obviously absurd.

Thus the index of diversity is apparently not applicable to numbers of plant species present in quadrats. The reason would seem to be that the formula takes no account of the amount of space occupied by the individual. In the insect populations first studied by Williams, sample size was defined by number of individuals—a fundamentally different method of sampling from that of taking quadrats, in which sample size is defined by *area*. The method of sampling an insect population comparable to taking a quadrat would be to take all the insects present in a given volume of space at any instant. While Williams' formula and the index of diversity derived from it may be valuable in some cases, it appears that the theoretical basis of its application needs further study.

E. W. JONES.

Imperial Forestry Institute,
Oxford.

[1] *J. Ecol.*, **32**, 1 (1944).

I HAVE read with interest Mr. Jones's letter on the results of the application of the logarithmic series and the index of diversity to his quadrat observations I completely agree with him that the theoretical basis requires further study, as also does the field application to both animals and plants. The object of my publication, which gave a few cases selected over a wide field, was to stimulate the production of new data whether in support of the theory or not.

The essential difference between sampling in insects based on numbers and in plants based on area was emphasized by me both in the paper quoted and in an article in *Nature*[1]. The application to botanical problems of a theory based on numbers of individuals was justified on the assumption that within one ecological formation the number of individuals could usually be considered as proportional to the area This is only true if the size of the area sampled is large enough to contain a fair sample of the vegetation. In spite of this difficulty, I was surprised to find that in the sets of data that I collected almost at random from botanical literature, the results were consistent with the logarithmic series, and gave not unreasonable estimates of the numbers of individuals on a quadrat. If Mr Jones's figures do not so fit, then it will be interesting to find the reason.

Even in animals, however, it is not always necessary to know the exact number of individuals in order to apply many of the general principles of the log series, including the index of diversity. For example, if two random samples of insects from the same population by the same method give x individuals of 40 species and $3x$ individuals of 60 species, then it is possible to say that $\alpha = \frac{60-40}{\log_e 3} = 18{\cdot}2$, without knowing the value of x, except that it must not be too small. This very closely resembles the case of two quadrats of size 1 and 3 units with an unknown number x of individuals on each unit area

In the limits of a letter, Mr. Jones cannot give all the essential data, but I will take first his statement about quadrats of 1/20, 1/8 and 1 square metre giving $\alpha = 1{\cdot}2$. This would suggest, on the basis of the log series, that if there were x species on 1/8 sq. m. there should be approximately $x - 1{\cdot}1$ on 1/20 sq m. and $x + 2{\cdot}5$ on 1 sq. m. ($x - \alpha \log_e 2{\cdot}5$, and $x + \alpha \log_e 8$). On the other hand, his data for several quadrats of 1/8 sq m. on the same area giving $\alpha = 7$ would imply that if there were x species on 1/8 metre, there would be about $x + 14{\cdot}5$ on $8 \times 1/8$ sq. metres; in other words, that eight separated quadrats of 1/8 sq. metre gave 12 species more than 1 sq. metre in a block. I suggest that the obvious explanation is that there was a strong aggregation of plants of each species in groups When this is occurring, there will be very great differences between single small quadrats both in number of species and number of individuals, and one would not expect conformity with the log series unless the size of the sample was considerably increased. It is pointed out in the paper quoted that the application of the log series to quadrats is only justified if the number of individuals in the quadrat is large compared with α. In the locality studied by Mr. Jones it seems likely that an area of 1/20 m., with plants as large as *Calluna*, might easily contain only one or two individuals.

Whether or not the whole conception of the log series could be extended to allow for aggregation, that is, to include a measure of it, I do not know,

but it is an interesting possibility. For the moment, I think it is better to say that with extensive aggregation the size of the sample must be increased.

I trust that I have done justice to Mr Jones's remarks, without having access to his data.

C. B. WILLIAMS
Rothamsted Experimental Station,
Harpenden, Herts.

[1] *Nature*, **152**, 264 (1943)

Colour Vision of the Fovea Centralis

I HAVE read with great interest the letters of Drs. Stiles, Thomson and Pirenne in *Nature* of February 10, in which among other things Konig's early work is mentioned. Some experiments to be described below indicate, I think, that the factors involved are more complicated than has previously been supposed. Mr Willmer is under the impression that it is only the fovea centralis that suffers from some form of dichromatism. I find, on the contrary, that it is a considerable area of the retina which is affected at times by this defect; all that has to be done to make the greater part of the retina appear dichromatic is sufficiently to reduce the visual angle of the test object.

When König investigated the colour vision of his fovea centralis, and found dichromatism there, he found he had to preserve very strict central fixation, since small deflexions of the eye axes caused the true colours of the test objects to be perceived. Mr. Willmer[1] found a similar state of affairs "If the eye is focused not on the centre of the circle (circular test object) directly but on the point *A*, about 4 cm. from the centre of the circle, then all the quadrants stand out in their true colours". Now, I do not find this, and neither does my observer, G. W. J. In our cases, if the test object is small enough to cause dichromatic vision on the fovea centralis, then it is also small enough to cause similar dichromatism on whatever part of the useful retina the image falls.

Clearly there is here a marked difference of observation. But there is another difference even more marked which must be alluded to. Mr Willmer used as his test object a circle 2 cm. in diameter, which was divided into quadrants. He found that the colours of these quadrants became modified when the test object was viewed with one eye from a distance of about 3 metres. I have myself used his test objects, which he very kindly placed at my disposal for the purpose, and I found that I required a much greater distance than 3 metres for dichromatism to show itself.

The test object I have been employing consists of a bright yellow square, the dye used being a saturated solution of picric acid in water. If the square had 1 cm. sides, the distance required to exhibit dichromatism, by the square becoming white, would be approximately 16 metres. It would seem from these facts that my fovea centralis is more 'resistant' to dichromatism than Mr. Willmer's in the sense that the test object has to be reduced in size much more for me than it has for him.

Two of my observers, E. C. T. and J. E. T., obtained substantially similar results to myself; on the other hand, two other observers, J. L. de S. and G. N. J., approximate more to Mr. Willmer in their experimental findings. It is clear that observers differ in detail, but in this important particular they are all alike. all find that dichromatism is not a property of the fovea centralis alone, but is present also in the more peripheral parts of the retina. The following example brings out this point clearly

The observer G. W. J. found that his fovea centralis was trichromatic when the distance of the test object was 3 metres from his eye. It was dichromatic when the distance was 4 metres The demarcation between the two types of vision occurred at about 3·6 metres. When a fixation point 4 cm. to one side of the test object was fixated, trichromatism was found at 3 metres, dichromatism at 4 metres, the transition between the two types of vision occurring at 3·3 metres. When the fixation point was 8 cm., the distance in each case is somewhat less, and the transition occurred at 2·9 metres

It is relatively easy to explain a dichromatism which affects a limited portion of the retina such as the fovea centralis. One can suppose, as Mr. Willmer has done, that an essential sensory structure such as that responsible for the blue sensation is absent from this region. It is much more difficult to explain a dichromatism which appears sometimes and not at others throughout a large area of the retina, and seems to vary according to the size and distance of the test object.

An attractive hypothesis would be: when objects produce on the retina images smaller than a certain size, the blue receptors which are stimulated become so few in number that their impressions fail to get through to consciousness. I find, however, that this supposition is contrary to the observed facts. If the process taking place was one of blue blindness, then one would expect white objects to appear yellow, since this is the combined result of stimulating the remaining red and green receptors. But such is definitely not the case, for we do not find that white becomes yellow; quite the contrary, it is yellow which becomes white.

In support of the contention that the dichromatism is not caused by blue blindness, the following experiment may be quoted. The observer takes up a position in respect of a yellow test object at which it is just beginning to be confused with a white test object of the same shape and size. He now places a deep blue filter in front of his eyes and looks at the brightly lit sky for several minutes. Having reduced the sensitiveness of his blue receptors by this technique, he suddenly removes the filter from his eyes and without delay critically examines the yellow and white test objects. He finds both of them to be a brilliant yellow; in other words, he gets a result which is entirely different from that produced by a reduction of the size of the test object. Whereas inhibiting more or less completely the blue receptors causes white to become yellow, the dichromatism produced as a result of reducing the size of the test object causes yellow to appear white.

When test objects having colours other than yellow are investigated, it will be found that the following changes occur: red and orange remain unchanged; yellow, yellow-green and green have blue added to them; blue-green remains unchanged; blue, violet, mauve and crimson have blue subtracted from them.

It seems that the addition of blue to some colours and its subtraction from others points to the existence of quite a complicated mechanism which sharply differentiates the colours. This mechanism may depend on the brightness of the colours, since yellow, yellow-green and green are relatively bright colours, whereas blue, violet, mauve and crimson are relatively

dark ones The fact that blue is added to some colours and subtracted from others accounts, I think, for the fact that white remains unaltered.

Further experiments are in progress in order to determine more exactly the nature of the colour change, and the means by which it is brought about.

I should like to thank J E. T., J. L. de S., G N. J. and E. C. T. for the trouble they have taken in acting as observers for me.

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[1] *Nature*, **153**, 774 (1944)

Nutritive Value of Coconut

IN NATURE of September 30, 1944, p. 437 occurs the statement : "and from these accounts it appears that babies fed entirely on coco-nut prepared in various ways until they are more than eighteen months old may be as healthy as those that are breast-fed".

The kernel of the coconut contains 35–45 per cent of oil, about 15 per cent of carbohydrates and a little less than 5 per cent of proteins of low biological value for infants The kernel is very indigestible for adults and more so for infants when taken in large amounts, because of the great quantity of fibrous matter it contains.

The commonest preparation in the diets of those who consume much of this nut is 'coconut milk'. This is prepared by kneading grated coconut into two or three lots of water and mixing them together ; the emulsion thus formed has much the appearance of cow's milk.

The analysis of coconut milk shows that the greater part of the oil has gone into emulsion with some of the protein and carbohydrates, and the residue of the grated nut contains all the cellulose and other indigestible matter of the kernel. It must be in this form, perhaps after mild fermentation, that coconut is given to infants. Supposing an ounce of grated coconut is used to prepare two ounces of milk, then the milk will contain less than 0·5 gm. of protein, about 5 gm. of fat and 1·5 gm. of carbohydrates per oz. ; there will be about as much sodium chloride and about half as much calcium as in human milk. Coconut is notoriously deficient in vitamins, and the milk contains a little thiamine, probably enough to deal with the metabolites from the small amount of carbohydrates in the milk, but there are only traces of carotene and ascorbic acid.

Undoubtedly biological adaptations have taken place, whereby some races are able to digest and find ample sustenance in foodstuffs which would not bring health and longevity to peoples of some other races. Probably coconut milk can supplement human milk to a small extent. It is, however, difficult to believe that the infants of any race can be weaned and thrive for a year or more on an oily diet deficient in proteins and calcium and containing only traces of vitamin A (carotene) and ascorbic acid.

Statements concerning native diets in many parts of the world are often at variance with our newer knowledge of nutrition ; very little knowledge exists of the dietary habits of the races of the world. There is an urgent need for dietary surveys to be carried out by scientific workers well acquainted with the difficulties of the subject. Such surveys will be of the greatest importance to supplement and perhaps modify some of the present views on human nutrition founded to a great extent on animal experiments. But all such surveys must be accompanied by surveys of the growth and state of nutrition of all classes among each people.

LUCIUS NICHOLLS

THE term 'coconut milk' is usually applied to the fluid contained in the centre of the nut It seems to have a very low nutritional value, containing only about 0·4 per cent of protein, 5 per cent of carbohydrate and a negligible vitamin and calcium content. Its calorific value is only about 20 per 100 gm

The flesh of the fresh coconut, on the other hand, contains, according to the figures I have by me, a little more than 4 per cent of protein, which is certainly of poor biological value, about 39 per cent of fat and rather less than 9 per cent of carbohydrate, giving the relatively high calorie value of 400 per 100 gm The calcium and iron contents are low. The only vitamin analyses I have for the flesh of the fresh fruit show a very small vitamin B_1 content of 0 03 mgm. per 100 gm. and about 2 mgm of ascorbic acid per 100 gm Vitamin A, either preformed or as carotene, is almost certainly absent.

Broadly speaking, therefore, the criticisms contained in Dr. Nicholls' letter can be sustained.

J. C. DRUMMOND.

Linoleic Acid, α-Tocopherol and Other Fat-Soluble Substances as Nutritional Factors for Insects

IT is now well established that, for growth, insects require a sterol in the diet. We have now established the need for other fat-soluble factors in experiments on the nutrition of a number of insects. Thus the caterpillars of *Ephestia kuehniella* grow very badly on an artificial diet consisting of casein, glucose, yeast, cholesterol, salt mixture and water. A few reach the pupal stage after a long time, but moths invariably fail to emerge. With *Ephestia elutella*, growth is relatively better on such a diet ; but again, the moth fails to emerge. This deficiency is entirely overcome by adding wheat germ oil in quantities of approximately ½–1 per cent of the diet.

We have saponified wheat germ oil and tested the two resulting fractions (saponifiable and unsaponifiable) separately and combined With both these fractions growth is as good, or almost as good, as with wheat germ oil. With the saponifiable fraction alone, *Ephestia kuehniella* still grows rather slowly, but those which reach the pupal stage ultimately emerge as normal moths. With *E. elutella* growth is almost as good as with wheat germ oil ; and emergence is normal. In the presence of the unsaponifiable fraction alone both species grow very badly, and the few moths formed never emerge. Thus it appears that *Ephestia kuehniella* requires two factors contained in wheat germ oil, one saponifiable and the other unsaponifiable, while *E. elutella* probably requires only the saponifiable factor.

Further tests have made it beyond doubt that the saponifiable factor is linoleic acid. With linoleic acid and the unsaponifiable fraction, the moths of *E.*

elutella and *kuehniella* always emerge If linoleic acid is added to the diets in insufficient quantities moths emerge, but are incompletely developed and the wings are partly or entirely lacking in scales By adding graded doses of linoleic acid to the diet, all transitional stages between failure to emerge and normal moths can be produced, namely, deformed moths with naked wings, normal moths with naked wings or with wings more or less patchy The same result has been obtained with graded doses of wheat germ oil. Imperfect moths are also formed when the diet contains oils poor in linoleic acid, such as coconut oil, allenblackia oil or lard.

The unsaponifiable factor in wheat germ oil which is required by *E kuehniella* is almost certainly vitamin E A diet which contains the saponifiable fraction of wheat germ oil or linoleic acid is greatly improved by the addition of pure α-tocopherol, in some cases even more than by the addition of the unsaponifiable fraction There are, however, indications that the favourable effect of vitamin E is not specific Lard, which is considered to be lacking in vitamin E, certainly contains something as efficient as the unsaponifiable fraction of wheat germ oil, if not more so. Finally, we have succeeded in demonstrating that ethyl- or propyl-gallates have an effect the same as, or similar to, vitamin E. This would suggest that the effect of the unsaponifiable factor is not a specific one, but that of an antioxidant which stabilizes linoleic acid.

There are, however, indications that linoleic acid plus a suitable antioxidant are not the only factors of importance concerned in this reaction. If it were merely a matter of having sufficient linoleic acid in the diet and having it efficiently stabilized, one would expect that growth-rate and degree of scaliness of the wings would go together, so that the growth-rate would always be high where the moths are normal, and always low where the wings are scaleless or patchy. This, in fact, is not the case. With the saponifiable fraction alone, growth of *E. kuehniella* is slow, but the moths are perfect, while with lard, growth is fast but the wings are imperfect. This suggests that a third factor must be involved in the reaction.

The consequences of a lack of linoleic acid, namely, failure to emerge, or emergence of moths with the scales missing to a greater or lesser extent, are different expressions of the same condition. The moth inside the pupal skin seems to develop normally until emergence, with the scales formed on the wings. When the moth emerges, the missing scales are always found on the inside of the cast exuvia. In the extreme case, the scales seem to stick firmly to the pupal case not only in the region of the wings but also elsewhere, notably the abdomen, so that emergence is impossible. This shows that a failure of the scales of the moth to separate from the pupal skin is the cause of the abnormal condition; this may be due to failure to excrete sufficient moulting fluid It is interesting to note that the condition of incomplete wings which arises from a lack of linoleic acid is similar in appearance, if not perhaps identical, to a genetical aberration in *Ephestia kuehniella* described by Kuhn and Henke[1] under the term "Glasflügeligkeit". This perhaps suggests that the physiological action of this particular gene is concerned with the linoleic acid metabolism.

We have so far not succeeded in demonstrating the need for linoleic acid, vitamin E or other fat-soluble factors which are contained in wheat germ oil in insects other than those belonging to the genus *Ephestia* (*E cautella* as well as *kuehniella* and *elutella*). The very closely related species *Plodia interpunctella* certainly does not require linoleic acid, and probably none of the other factors. Other insects which we have tested, including about ten species of beetles and moths, do not seem to be in need of any fat-soluble factors in addition to sterols, and this agrees well with recent work on the dietetics of insects which has been conducted in other laboratories.

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Jan. 26

[1] Kuhn, A., and Henke, K., *Abh Ges Wiss Gottingen, Math Phys. Kl*, N F, 15, 1 (1929)

Acaricidal Property of a New Insecticide, Hexachlorobenzene

FOLLOWING closely on the several recent demonstrations of the considerable insecticidal potency of 'D.D.T.' (dichloro-diphenyl-trichlorethane) it is surprising to find another substance which, on preliminary trial, promises to be at least as good, and in some ways even better than, 'D D.T.'. Through the courtesy of Imperial Chemical Industries, Ltd., I have recently had the opportunity of carrying out a few trials with a substance temporarily designated '666' which has been recognized for some little time by I.C.I. research workers as possessing unusually active insecticidal properties. This substance, which may now openly be referred to as hexachlorobenzene, has the general formula $C_6H_6Cl_6$ and is a very remarkable compound in that the extraordinary insecticidal properties are held solely by the γ isomer It is understood, however, that a general statement is shortly to be made by those who have been engaged in the development of this substance as an insecticide, when details on that interesting point will be published.

A few tests recently carried out at this Laboratory on the action of hexachlorobenzene on guinea pig lice showed it to be at least as effective as D.D.T. It was also found to be exceedingly toxic to the freshwater crustaceans, *Cyclops*, *Daphnia* and particularly to *Diaptomus*; but in whatever other direction this new substance may excel, its action on parasitic acari promises to be one of the most potent, as was indicated by comparative trials carried out on rats severely affected by notoedric mange. In these trials a comparison was drawn between the efficacy of 1 per cent solutions in liquid paraffin, or olive oil, of hexachlorobenzene, benzyl benzoate, tetraethylthyuram-monosulphide ('Tetmosol') and 'D.D.T.'. Of these four substances hexachlorobenzene was found to be much the most active, and, apparently, without any danger to the treated animals. 'D.D.T.', on the other hand, showed very little effect, and in a second series of trials, when used in 2 per cent strength, led to the death of some of the experimental rats after the development of marked hyperæsthesia and frequent clonic muscular spasms.

A preliminary cleansing of the affected parts of the rats with soap and water was not carried out in these tests, nor was the whole surface of the body treated with the dressings, which were applied only to the affected (hairless) parts. As complete cure

was brought about under these relatively difficult conditions, and living mites were not found in the old lesions, it is thought that in all probability hexachlorobenzene will ultimately prove to be of great value in the treatment of psoroptic scabies (including 'sheep scab') in animals, and of sarcoptic scabies in animals, and also in man.

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'D.D.T.' as a Sheep Blowfly Dip

THE powerful toxic action of 'D.D T' on many species of flies has made possible a new method of attack against the sheep blowfly *Lucilia sericata* (Mg) and related species As the following experiments indicate, control may be achieved by the direct action of a 'D.D T' dip on the blowfly while the insect is searching the fleece for a site suitable for egg-laying.

The preliminary laboratory experiments were made by Dr. E. T. Burtt of the Unit of Insect Physiology (Agricultural Research Council), who showed that sheep wool dipped in an emulsion containing 0·5 per cent 'D.D.T.' was toxic to laboratory-bred specimens of *L. sericata*. The following field tests gave results in keeping with this observation and demonstrated that the toxic effect could take place rapidly enough to prevent gravid females of *L sericata* from ovipositing on sheep.

Two dipping trials were made on farm flocks consisting mainly of Welsh mountain sheep. In both cases the same dipping procedure was adopted and the same 'D D.T.' emulsion (*M* 21) used.

In the first trial eighty-one sheep were dipped, the concentration of the bath falling from 0 3786 to 0·3264 per cent 'D.D.T.' in the course of the dipping. The sheep remained free from strike throughout the period of the experiment, August 8–September 18, a total of forty-two days. It was not possible to have a control group grazing with the experimental flock; but chemotropic experiments made on this particular farm indicated that conditions for strike were better in August and September than in the four weeks prior to dipping, when ten strikes were recorded in the flock. Further, bad cases of maggoting were reported on neighbouring flocks.

The second trial comprised a total of 430 sheep grazing on five different regions of one farm. Each grazing unit was divided into two equal groups as regards breed, age and sex. One group was dipped with the 'D.D.T' emulsion and the other with a commercial arsenical dip. The 'D.D.T.' concentration fell from 0·4540 per cent to 0·2388 per cent in the course of the dipping.

The experiment lasted from August 29 to October 13, a period of forty-four days. Three strikes occurred on 'D.D.T.'-dipped sheep; one of these was a re-strike. Twenty-one strikes occurred in the control group which had been dipped with the commercial preparation; no re-strikes were recorded in this group. In the control group the first strike occurred six days after dipping and in the 'D.D.T.' group twenty-four days after dipping, by which time thirteen strikes had been recorded on the controls.

The following experiments clearly show that the effectiveness of the dip lay in its direct action on the blowfly.

Three weeks after dipping, specimens of *L. sericata* were captured from undipped and 'D.D T.'-dipped sheep. Of twenty-five flies caught on the undipped sheep, two died in twenty-four hours Of thirteen caught on the 'D.D T.' group, nine died in twenty-four hours All the flies which died, including those caught on the control group, showed symptoms of 'D D.T.' poisoning within 15–30 minutes of capture. A similar test five weeks after dipping showed one death out of sixteen flies captured on the controls and five out of sixteen captured on the 'D D T.' group

Tests in which gravid females of *L sericata* were kept in contact with the fleece of a 'D.D.T'-dipped sheep showed that even five weeks after dipping, 30–60 seconds contact was sufficient to have a toxic effect on the flies.

The action of the dip in preventing oviposition was clearly demonstrated by tests with artificial attractants The Hobson[1] technique was employed, and five 'D D.T'-dipped with five undipped sheep were used in each experiment

NUMBER OF EGG BATCHES LAID IN REGION OF ATTRACTANT

Date 1944	No. of days after dipping	Sheep dipped with 'D.D.T'					Control group undipped				
Aug. 8	0	No test									
,, 10	2	0	0	0	0	0	2	1	3	1	1
,, 15	7	0*	0	0	0	0	0	2	2	1	0
,, 23	15	0	0*	0	0	0*	4	3	8	7	3
,, 30	22	0	0	0	0	0*	3	0	2	–	–
Sept. 7–11		Weather conditions not suitable for tests									
,, 12	34	0	0	0*	0	0*	3	2	–	–	–
,, 19	41	0	0*	0	0	0	Controls not available				
,, 21	43	0	0	0	0	0	3†	2†	0†	0†	0†

* From 3–6 scattered eggs laid, except in the case on September 19, when 15 eggs were found.

† The sheep used as controls on September 21 had been dipped with a proprietary arsenic dip on September 19.

The accompanying table summarizes the results obtained. On no occasion was a complete and compact batch of eggs laid on the 'D.D.T.'-dipped sheep, whereas oviposition was invariably induced on the control group. The results obtained on September 21 are of particular interest because the control group had been dipped with a proprietary arsenic dip only two days previously and their fleeces were sticky and had a strong odour; yet oviposition occurred on them but not on the sheep which had been dipped with 'D.D.T.' some six weeks previously.

In the course of the 1945 blowfly season, the dip is to be given extensive field trials and attempts are to be made to increase its effectiveness by combining an attractant with it, thus making the dipped sheep act as blowfly traps.

I wish to thank Mr. L. Davies for assistance with the field experiments and Dr. J. G. Mitchell of the D.S.I.R. Chemical Laboratory for the preparation of the 'D.D.T.' emulsion and for determining the 'D.D.T.' concentrations mentioned above.

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[1] Hobson, R. P, *Ann. Appl. Biol.*, 24, 627 (1937).

Hydrogen Sulphide Gas as a Preventive of Putrefaction

In a collection of old microscope slides recently re-examined, a series came to light illustrative of observations made by me some twelve years ago and not hitherto published. They are perhaps of sufficient interest to be put on record now

During the course of work on the sterilization of dried hides from anthrax[1], the lines of which were suggested by observations by Andrjewski[2], on the toxicity of hydrogen sulphide for anthrax spores, it was found that anthrax spores could be killed by exposure in anaerobic jars to an atmosphere of this gas.

To find out whether hydrogen sulphide was toxic in the same conditions to other micro-organisms and might therefore delay or prevent putrefactive changes, the following experiment was done. Pieces of raw hide newly removed from the animal were put in anærobic jars—either suspended or laid in petri dishes. The air in the jars was then exhausted by means of a vacuum pump and hydrogen sulphide run in from a kip—being passed first over 1 per cent caustic soda to remove any trace of hydrochloric acid that might be present. The jars were allowed to stand at room temperature or at 37° C. Cuttings from the samples under treatment were taken at intervals, sectioned, stained and compared with cuttings from the same hide kept in air in similar jars at the same temperatures The hydrogen sulphide jars were refilled at once with the gas after each time of opening

It was found that in the pieces kept in an atmosphere of hydrogen sulphide, putrefaction was almost entirely checked for a period of at least a week at 37° C. and a month at (approximately) 20° C. One hydrogen sulphide jar was kept sealed (and forgotten) for eight years At the end of that time the sample of hide was still moist and sufficiently intact to be sectioned, and though the epidermis and cellular structures in general had disappeared and there was considerable breakdown of the fibre bundles, the main outlines of the hide structure were still traceable.

Fig 1

Fig 2.

Fig. 1. OX HIDE KEPT FOR THREE DAYS IN AIR AT 37° C. IN A SEALED JAR.
The epidermis and all the other cellular structures (sebaceous and sweat glands, linings of hair follicles and interstitial cells) have disappeared. The fibre bundles are loosely woven and are showing signs of breakdown.

Fig. 2. OX HIDE KEPT FOR SEVEN DAYS AT 37° C. IN HYDROGEN SULPHIDE IN A SEALED JAR.
The epidermis and other cellular structures are intact or practically so. The fibre bundles are compactly woven and show little or no sign of degeneration.

The accompanying photomicrographs illustrate the condition of the air-treated sample after three days at 37° C. and of that treated with hydrogen sulphide after seven days at the same temperature.

Unfortunately the section shown in Fig 1 was cut in the direction of the hair follicles and that shown in Fig. 2 across their main direction. In spite of this, however, the much better state of preservation of the sample shown in Fig. 2 is obvious

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[1] Robertson, *J Hyg*, 32, 367 (1932)
[2] Andrjewski, *Amer J. Bact*, 16 151 (1928).

Vernalization of Rice by Short Days

In a previous communication[1], the effectiveness of the method of vernalization of rice by short days has been reported. The method has been tried further with several varieties of rice grown in Bengal, and interesting results of agricultural importance in one winter variety, 'Rupsail', have been noted.

Flowering duration of this variety has been reduced from 133 to 47 days by this method. So far as we are aware, flowering of winter varieties of rice within such a short period has not been reported previously. By applying short days to several varieties of rice, Alam[2] came to the conclusion that all varieties require a minimum period of 30 days for vegetative growth and a succeeding period of about 30 days of short-day treatment for coming into flower.

This acceleration of flowering has great possibilities for the cultivation of rice in Bengal. First, a variety of fine rice could be grown in a much shorter time; secondly, by inducing early maturity, it could escape flood; and thirdly, early harvesting would leave sufficient time for the preparation of fields for the crops following in rotation.

A full report of this work will be published elsewhere. We wish to express our thanks to Prof. S. P. Agharkar for encouragement and facilities to carry out this investigation.

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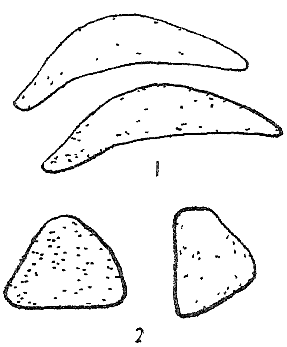
Nov. 7.

[1] *Nature*, 153, 378 (1944)
[2] See Sci. Rep. Rice Res. Stat., Sabour, Bihar (India), 1940–41.

Two New Records of *Sphacelia* from Mysore

In the course of his studies on the sugary disease of *Sorghum vulgare* caused by *Sphacelia Sorghi* McRae, Ajrekar[1] recorded three other wild grasses, namely, *Andropogon caricosus* var. *molicomous*, *Ischæmum pilosum* and *Pennisetum alepecuros* as having the *Sphacelial* stages of an ergot. Sclerotial stages were observed by him only on the last-named host, and he pointed out that heavy infestation by a species of *Cerebella* competed with the formation of sclerotial stages in other cases.

Collections of ergot on wild grasses in Mysore I have made included *Sphacelial* and sclerotial stages



1 SPORES OF *Sphacelia* ON *Brachiaria distachya* 2 SPORES OF *Sphacelia* ON *Amphilophis pertusa* ×800

on *Brachiaria distachya* Stapf. and *Sphacelial* stages associated with undeveloped or partially developed sclerotia on *Amphilophis pertusa* Stapf. In all cases there was heavy infestation by *Cerebella*, which in fact reveals the presence of *Sphacelia* among a group of unaffected plants. Individual flowers in the spikelets of *Brachiaria distachya* are affected. Soon after infection there is a secretion of a drop of sugary solution, which at first is translucent, later on hardening into a whitish crust associated with saprophytic yeast cells. Numerous oblong-ovate spores (which are slightly arcuate and slightly pointed at the tips) of the *Sphacelia* become embedded in the nectar The spores measure 12 6–19 × 3·8–6 3 μ. Subglobose to spherical sclerotia are formed only in a few cases unaffected by *Cerebella*. In the absence of germination stages of the sclerotia, the identity of the *Claviceps* species remains obscure

The Sphacelial stages on *Amphilophis pertusa* are also restricted to individual florets. Partial development of sclerotia due to infestation of *Cerebella* have been observed in some cases. The conidiospores are numerous, hyaline, borne on conidiophores developed as a felt on the surface of the ovary. The spores are distinctly triangular, somewhat rounded at the ends, measuring 8 8–11·4 × 6·3–7·7 μ. Such a type of triangular spores is at variance with the *Sphacelia* of *Claviceps* species recorded both on members of Gramineæ and Cyperaceæ. On account of the differences in size and shape of the spores, the name *Sphacelia Amphilophidis* is tentatively proposed for the accommodation of the fungus. Detailed description and diagnosis of the species are being published separately.

Grateful thanks are due to Dr. L. N. Rao, professor of botany, University of Mysore, for kind encouragement.

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[1] Ajrekar, S. L., *J. Ind. Bot. Soc.*, **5**, 55 (1926).

Scattering of Light in Crystals

SINCE its discovery[1], early in 1928, the scattering of light with altered frequency has been investigated in many crystals, and much valuable information has been accumulated. The significance of the results and their relation to theories of the solid state are clearly matters of great interest.

The outstanding result of the experimental studies is that the atomic vibration spectrum of crystals in the infra-red region reveals itself in light-scattering as a set of discrete frequencies, the approach to monochromatism being the more complete the more perfect the crystal, and the lower the temperature at which it is studied. It is particularly significant that this feature obtains not only in respect of the so-called internal vibrations of the ions or molecules comprised in the crystal, but also in respect of their translatory and rotatory oscillations which are characteristic of the crystalline state As a typical case, calcite may be mentioned Dr. R S Krishnan has recorded extremely intense spectra with this crystal employing the 2537 A radiations of a water-cooled, magnet-controlled quartz mercury arc as the exciter and giving prolonged exposures. Besides the internal vibrations of the CO_3'' ions and their translational and rotational oscillations, octaves and combinations of these frequencies are also found recorded in the spectrum. All of them appear as sharp lines, *but not a trace of continuous spectrum is noticeable on the plates*.

Comparative studies with various substances in the molten and solid states make it clear that every mode of infra-red vibration which gives rise to appreciable variations of optical polarizability in the volume elements of a crystal also manifests itself as a frequency-shift Hence, as in the cases of gases and liquids, we are entitled to infer that the spectrum of light-scattering in a crystal is a faithful map of the fundamental infra-red vibration spectrum, excepting only the modes for which the symmetry excludes any variation of optical polarizability.

Recently, by a straightforward dynamical investigation[2], I have shown that the fundamental vibration spectrum of a crystal containing p sets of non-equivalent atoms consists of the $(3p-3)$ modes which repeat themselves in adjacent cells of the Bravais lattice, and in addition $21p$ other modes in which the phase alternates in successive cells. The prediction confidently made that those $21p$ modes should also manifest themselves in light-scattering has been strikingly confirmed by Dr R S. Krishnan[3] in the case of diamond.

It is clearly impossible to reconcile the facts stated above with the theories of the solid state which assume, or claim to show, that the atomic vibration spectrum of a crystal in the infra-red region is a continuous one To effect any such reconciliation, it would be necessary to invent a mechanism which could transform the assumed continuous spectrum of frequencies into a discrete line spectrum by a process of exclusion. One such mechanism which has often been suggested is that the phases of the infra-red vibration are perfectly coherent over the whole volume of the crystal, in consequence of which all the scattered radiations disappear by optical interference except those arising from the so-called limiting modes of vibration, $(3p-3)$ in number, the phase wave-lengths of which are comparable with the length of the light waves and satisfy the Bragg condition for reflexion. To this suggestion, however, there is a fatal objection, namely, that $21p$ other modes which have much smaller phase wave-lengths not satisfying this condition are also observed in light-scattering, while the infinitely numerous others which are also assumed to exist in the aforesaid theories fail to manifest themselves. A further objection is that, in actual crystals, the assumed coherence of phase can scarcely be expected to extend over sufficiently great volumes for optical interference to be effective. For the latter reason, the continuous spectrum assumed to exist in such theories should manifest itself fully in light-scattering or at least give an observable indication of its existence. Since this is not the case, we can only infer that the postulated continuum does

not exist in the infra-red region of frequency. We are, of course, here not discussing the low-frequency or elastic solid vibrations in which the discrete atomic structure is not explicitly involved.

C. V RAMAN.

Indian Institute of Science,
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Feb 14.

[1] Raman, C. V, Ind. J. Physics (1928)
[2] Raman, C. V., *Proc Ind. Acad Sci.*, A, **18**, 237 (1943)
[3] Krishnan, R. S, *Proc Ind Acad Sci*, A, **19**, 216 (1944).

X-Ray Crystallography of Kojic Acid

AT a time when its identity was uncertain, specimens of the compound isolated by M. A Jennings and T. I. Williams[1] from *Aspergillus effusus* were examined in order to determine its molecular weight. The compound was later shown to be kojic acid. It forms monoclinic needles elongated along [100] and showing the forms {100}, {010} and {021}. The following data for the unit cell were obtained from X-ray oscillation photographs $a = 3{\cdot}85$, $b = 18{\cdot}4$, $c = 8{\cdot}84$ A.; $\beta = 74°$, correct to about $\pm$ 1 per cent.

Absent spectra indicate that the space group is $P\ 2_1/c$ and the density determined by flotation in an ethylene dibromide-bromobenzene mixture is $1{\cdot}559 \pm 0{\cdot}006$ The space group allows any even number of molecules in the cell, and if four molecules are assumed the molecular weight is 142 ± 3. This value is in good agreement with the formula $C_6H_6O_4$ (mol. wt. 142) and with the quantitative analysis and cryoscopic determination of F. Traetta-Mosca[2].

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[1] *Nature*, **155**, 302 (1945).
[2] *Ann Chim Applicata*, **1**, 477 (1914).

Long Duration of the Balmer Spectrum in Excited Hydrogen

LORD RAYLEIGH has reported recently[1] the results of a new experimental determination of the duration of the emission of hydrogen Balmer lines, H_α, H_β and H_γ. Hydrogen (pressure $0{\cdot}2$ mm. mercury) was excited by an electrodeless discharge in a tube having the form of a square ring connected with a side tube, through which it was exhausted. Each discharge (of very short duration) produced a luminous jet squirting out of the discharge space, along the tube. The light emitted by the jet contained the Balmer lines in question. From the measurements of the speed of the jet (by means of a revolving mirror) and of the decay of luminosity at various distances along the tube, the durations of these lines were determined. In some conditions they appeared to be roughly one thousand times greater than the values calculated theoretically as well as those given by previous experiments. As Lord Rayleigh states, the difference of behaviour of the lines is not very marked, and not always noticeable.

Since, presumably, one of the purposes of Lord Rayleigh's paper was to rouse discussion, I should like to put forward a possible explanation of his unexpected results. The mean duration of lines is not always identical with the mean life in initial states of corresponding transitions. This would be the case only if no transitions from higher levels to the initial level of the line (cascade transitions), no recombination of ions, no transfer of excitation energy from atoms or molecules in metastable states, no 'imprisonment' of radiation, etc , took place. From these possibilities the first two, namely, cascade transitions and recombinations of ions, seem to be not excluded in Lord Rayleigh's experiments. Thus the most probable cause of the prolonged duration of the H_α, H_β and H_γ lines seems to be the recombination of atomic hydrogen ions.

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Jan. 28.

[1] Rayleigh, *Proc Roy. Soc*, A, **183**, 26 (1944), cf also *Nature*, **155**, 84 (1945)

Vibration in Telegraph Wires

Two winters ago while motoring over a route traversed daily for many years, we observed this phenomenon for the first time. Hence the conditions giving rise to it must be rather exceptional The vibration was so striking and unusual that we stopped the car to exclude the possibility of adventitious optical effects from that source. The time was about 9.15 a m.; the air clear and 'frosty'; the sun brilliant; and the wires heavily loaded with ice. There was a barely perceptible breeze blowing *across* the road.

On the left side of the road were the usual telegraph wires, and on the right a group of four thicker insulated wires carrying lighting current Both sets, although obviously under very different degrees of tension, were vibrating with considerable amplitude. The effect was general over several miles of road Ultimately the right-hand wires changed direction and ran off sharply at right-angles to the road (that is, parallel to the wind stream). No vibration could be observed in this stretch. Later we ourselves turned right (that is, down wind) and here the standard telegraph wires also ceased to show any vibration.

In attempting an explanation several factors were reviewed. (1) The physical effect of temperature on the vibrating system, as defined by the 'sonometer' formula, can be ignored, as a drop of 40° C. only affects the rate by about $0{\cdot}1$ per cent. (2) From the dissimilar behaviour of the wires orientated across and parallel with the wind stream, we may safely presume that this cross flow is an essential factor. (3) Genesis from some random specific 'air velocity vibration resonance' correlation may be excluded, as two entirely dissimilar sets of wires were simultaneously in vibration.

In view of the above, we reached the conclusion of Gilbert *et al.*[1] that the vibration is initiated and maintained by the differential pressure effects resulting from an air flow across a wire of non-circular section; that this abnormal source of energy explains the abnormally high amplitude; that the visual effect is aided and intensified by the greatly increased thickness of the wires, and by the loading of the wires reducing the vibration rate below the threshold at which the persistence of vision obscures observation[2].

What surprised us at the time was that, despite the obvious relationship to a cross wind, the prevailing breeze was almost imperceptible.

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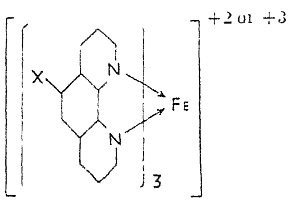
Nature, 155, 243 (1945)
[2] cf Bauchmetz and Whitehouse, Nature, 155, 243 (1945), "frequency approximately 10 a second"

Effect of Substituents on the Oxidation Potential of Ferrous *ortho*-Phenanthroline Complexes

IN a recent communication[1], Smith and Richter have measured the oxidation-reduction potentials of a series of substituted *ortho*-phenanthroline iron complexes.

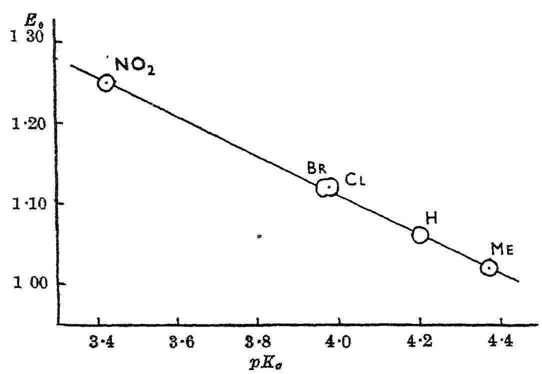


The values obtained show a marked trend with the dipole moments of the corresponding substituted benzenes. More striking, however, is the fact that a linear graph is obtained when these formal oxidation-reduction potentials are plotted against the (negative) logarithms of the dissociation constants[2] of the corresponding *para*-substituted benzoic acids.

E_0 and log K_a are, of course, proportional to the free energy changes of the corresponding reactions. Clearly, an electron shift, for example one towards the substituent group, which in the acid series raises the acid strength by increasing the repulsion on the proton, is similarly transmitted in the complex ion. The withdrawal of electrons is communicated through the co-ordinated nitrogen atoms to the central iron atom, to produce an increased binding of its electrons, and a proportionate rise in the oxidation potential

X	E_0 (volts)	pK_a X–⟨benzene⟩–COOH
NO_2	1 25	3 42_5
Br	1 12	3 97_1
Cl	1 12	3 97_7
H	1 06	4 20_8
CH_3	1 02	4 37_3

The equation to the line is $E_0 = 2{\cdot}08_2 - 0{\cdot}243(pK_a)$



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[1] Smith and Richter, *Ind Eng Chem.* (*Anal. Ed.*), **16**, 580 (1944)
[2] Dippy *et al*, *J Chem Soc*, 1888 (1934); 343 (1935); 644 (1936)

Causality or Indeterminism ?

I HOPE it will not cause *Nature* to lose caste for a very ordinary man to join in the discussion on causality v. indeterminism so ably dealt with by Prof. H. T. H. Piaggio, and to express thoughts that will at least be understood by all who try to read the exceedingly specialized correspondence columns.

I follow the line of argument that coin tossing is not really haphazard but governed by strict laws of causality, although the variation in launching and wind may be impossible scientifically to calculate. Incidentally, the alternative of red and black on a roulette board is the incalculable ideal, in that the ball launched round the board in the opposite direction to the spinning centre has to strike odd-shaped obstacles before rolling into the middle. Results have, I understand, for some obscure reason been chronicled for years.

When we come to atomic physics we get into heavy weather and we are not really helped by von Neumann's six laws, especially the one referring to the 'squared operator' which may convey that there is something wrong with the 'tote', but is otherwise entirely incomprehensible to the layman. Anyhow, at present the pundits plump for indeterminism.

How can this refreshing individuality in atomic physics, so stimulating in our dragooned world, react on 'homo sapiens' (sic) ?

In Schrödinger's attractive book "What is Life ?" with Darlington prompting him 'off', as they say on the stage, he tells us that we mortals are made a certain size in order that statistical results should obtain. A serious corollary, however, emerges in that genes are so small as to be subject to random changes as, for example, in the energy-level of their few constituent atoms. These changes are enough to account for mutants. Through no fault of our own, therefore, we may become the parents of monsters. May we now go further and be told by those who analyse the micromechanism that animates the brain whether there are there, constituent parts of such small size as also to be influenced by random atomic changes. If such be so, then the truly awful thought faces us, that all our wise decisions, all our noble or possibly questionable actions in life, are determined, not by our own high-charactered and noble 'ego', but by a microscopic atomic material part of our brain, over which we have no control, being bumped around on the quantum level.

These are grave thoughts, but if the latter hypothesis be true, although not exactly comforting, it would at least explain and indeed excuse many mistakes made in life by your obedient servant,

BRABAZON OF TARA.

RESEARCH ITEMS

Origin of South American and African Freshwater Fishes

William A. Gosline (*An. Acad Brasil. Ciencias*, **16**, No. 3; 1944) criticizes some of the arguments advanced by biologists who have marshalled geological evidence to agree with their own interpretation of the biological data. While the author does not attempt to offer final conclusions concerning the African and South American freshwater fishes, he summarizes the evidence supplied by the best-known freshwater group, and suggests lines of further investigation. These are included under four heads. (1) The compilation of up-to-date revisions of the groups of fish involved, together with the presentation of phylogenies of these groups based on palæontological, anatomical and physiological data. These would show the relationship of the fishes between areas as compared with those within areas. (2) The demonstration from various sources of evidence that certain groups have originated and evolved in fresh water, and that salt water has always formed a complete barrier to their dispersal. (3) The determination, so far as is possible, of the geographical distribution—past and present—of these groups, together with their ecological limitations. (4) The correlation of all material from the above lines of investigation, special account being taken of the environmental needs affecting fish dispersal, with the derived data for other animal and plant groups and with geological and climatic history.

Growth Hormones in Tetraploids

F. G. Gustafson (*J. Hered.*, **35**, 269; 1944) has shown that tetraploid marigolds have 58 per cent and 76 per cent as much growth hormone as their related diploid, while the autotetraploid *Lycopersicon pimpinellifolium* has 56·8 per cent of that of the diploid. This reduction in amount of growth hormone may be related to the well-known time differences in growth between diploid and tetraploid plants.

Mitosis and Cell Differentiation in the Blood

L. F. La Cour (*Proc. Roy. Soc. Edin.*, **62**, 73; 1944) has used new technical methods to investigate the chromosome behaviour and nuclear cycle in the origin of blood cells in man, mice, rats, cats and dogs. There is a unique difference between the precursors of myelocytes and erythrocytes in respect of the nucleic acid content of the nucleus. The pre-erythrocyte cells stain an intense red by the Pappenheim stain, whereas the pre-myelocytes stain pink. Similarly the chromosomes of the first type show a greater desoxyribose nucleic acid charge. In man with pernicious anæmia, the differences are accentuated. This leads on one hand to over-spiralization and abnormal division in the overcharged erythrocytes, and long thin chromosomes, incompletely spiralized in the myelocytes. As a result of the abnormal divisions with multiple spindles and chromosome bridges, the daughter cells often contain irregular chromosome numbers. Hypoploid cells have been found in the normal field mouse. Nucleoli are present in all precursor cells in the marrow and are later replaced by heterochromatin. Their presence is correlated with cell proliferation. The matured myelocytes in the mouse and the rat are tetraploid as a result of an abortive anaphase of the last division. White tetraploid cells occur in association with a shortage and red tetraploid cells with an excess of both nucleic acids in pernicious anæmia. Evidence is given which suggests that the enucleate condition of mature erythrocytes is due to the extrusion of nucleic acid and not of the nucleus.

Pre-harvest Drop of Apple Fruit

Pre-harvest drop of apple fruits which have reached or almost reached picking maturity is a serious problem confronting apple growers in America and, to a lesser extent, in Great Britain. Innumerable trials carried out in recent years have indicated that some control of this trouble may be effected by spraying the trees, shortly before picking maturity is reached, with growth-substance solutions The standard spray used contains ten parts of growth substance per million of spray; but L. Southwick reports (*Proc. Amer. Soc. Hort. Sci.*, **42**, 199; 1943) that stronger sprays may be more effective and that, while dusts which can be applied more easily are as effective as solutions with some varieties, they are less effective with others. Southwick, like M B Hoffman, A. V. Doren and L. J. Edgerton, finds dusts as effective as sprays with McIntosh apples. The addition of spreaders to the sprays is not necessary, but the sprays are ineffective if their application is followed by a spraying with water (or presumably rain) within two hours (E. L. Overholser, F. L. Overley and D. L. Allmendinger, pp. 211–219). Sprays given near midday are most effective, and the period of effectiveness may be as much as twenty-eight days, but is less if temperatures are high. The hormone sprays are without any direct effect on the firmness of the fruit or development of decay, breakdown and scald in store (M. H. Haller, pp. 207–210), but by delaying picking they may improve colour and taste and increase the size of the fruit as harvested by permitting the attainment of greater maturity (E. P Christopher and S A. Pieninzek, *ibid.*, **43**, 29; 1943).

Mercury for Grain-Pest Control

The method of grain-pest control as practised by the raiyats in certain parts of India involves the use of mercury. It concerns the protection of stored pulses against the bean beetle, and for this purpose a drop of mercury is placed in an excavated soap nut and lodged in the storage container. D. W. Wright, of the School of Agriculture, Cambridge, has made an attempt to assess the efficacy of mercury for the control of several of the commoner grain pests (*Bull. Entom. Research*, **35**, 143; 1944). Experiments showed that the vapour of mercury was fully effective in preventing reproduction of the grain weevil (*Calandra granaria*), the saw-toothed grain beetle (*Oryzæphilus surinamensis*), the lesser grain borer (*Rhizopertha dominica*), and the Angoumois grain moth (*Sitotroga cerealella*). Zinc and tin amalgams and calomel were less effective than metallic mercury. The efficacy of a given weight of mercury is increased by subdivision, a process which increases its total surface area. The substances used were found to emit a vapour which contained free mercury. Storage of insects in mercury vapour was found to have no effect on the viability of grain weevils, neither did it influence their subsequent reproductive capacity. The action of the mercury was on the eggs, which failed to hatch. Germination and spectroscopic tests on grain that had been stored for several months with mercury gave no indication

that any contamination had occurred. The grain weevil was able to breed vigorously in grain so treated.

Crocidolite Asbestos in Western Australia

BLUE amphibole (riebeckite) asbestos occurs in seams interbedded with banded ironstones of Nullagine age in the Hamersley Ranges of Western Australia. The petrology of the deposits and the associated rocks has been described by K. R Miles (Geol. Sur. W. Aust. Bull. 100; 1942), and there is also a report on the economic importance of the occurrences by J. S Foxall. The banded ironstones include sideritic cherts, magnetite- and hæmatite-bearing cherts and banded jaspers associated, as usual, with quartzites The ironstones are interpreted as chemical sediments in which the bulk of the iron was originally precipitated as ferrous carbonate. Under conditions of low-grade metamorphism, riebeckite has developed in these beds as (*a*) scattered needles; (*b*) massed aggregates of needles (potential crocidolite); and (*c*) seams of uniformly parallel cross fibres (crocidolite proper). In their geological setting, structure, composition and optical properties the riebeckite and asbestos occurrences are closely similar to those of the better-known South African deposits. The chief problem in both areas is the source of the soda required for crocidolitization. Riebeckite contains six per cent or more, whereas only traces of soda appear to be present in the adjacent formations. The current hypothesis that crocidolite occupies the place of pre-existing soda-rich layers in siliceous ironstones is therefore far from satisfactory. Another possibility is that soda may have been introduced (as in albite-schists) by emanations from plutonic sources, but the absence of igneous rocks and of regional metamorphism would seem to be inconsistent with this alternative. Both in Australia and South Africa the origin of crocidolite remains a geochemical enigma.

Viscosity of Compressed Gases

THE viscosity η of a non-ideal gas was considered in 1922 by Enskog, whose formula was checked for carbon dioxide and (by Michels and Gibson) nitrogen: $\eta = \eta_0 \ (1 + 0{\cdot}175b\rho + 0{\cdot}86b^2\rho^2)$, where η_0 is the ideal gas viscosity, ρ is density, and b is van der Waals' constant. O. Leipunsky (*Acta Physicochim. U.R.S.S.*, **18**, 172; 1943) has shown that the formula gives quite satisfactory results for a number of gases, with a tendency at high densities to show rather higher values than the experimental, due to the change of b with pressure. The formula is thus of service in technical calculations where compressed gases are concerned. With a suitable value of b the formula also applies to mixtures, where the mathematical theory is extraordinarily clumsy and incomplete.

Absorption Spectra of Substituted Benzene Sulphonamides

ALTHOUGH several publications have dealt with the ultra-violet absorption spectra of sulphanilamide derivatives, little has been done towards identification and characterization of the individual absorption bands. J. M. Vandenbelt and L. Doub (*J. Amer. Chem. Soc.*, **66**, 1633; 1944) have made a study of simple sulphanilamide derivatives and find that they have one single band of strong absorption (ε, about 17×10^3) in the accessible ultra-violet region, about 260 mμ in neutral solution, which shifts to shorter wave-length when the solution is made alkaline, and decreases in intensity with acidity. Simple substitution which does not change the basic ionization properties of the molecule has little effect on the wave-length of the band. With more complicated substitution, other bands appear. Sulphathiazole has a band at 257–259 mμ with the properties of the sulphanilamide band, and a band at 280–283 mμ which shifts to shorter wave-length in alkali and is not destroyed in $2N$ hydrochloric acid, and is probably due to the thiazole portion of the molecule. With sulphapyridine three bands are found, at 242, 261 and 311 mμ, the third being due to the pyridine portion. In alkaline solution the maximum at 311 mμ shifts to shorter wave-length and the peaks at 242 and 261 mμ apparently fuse to a single broad band of increased intensity at 245 mμ. With sulphadiazine a 257 mμ band is due to the *p*-aminobenzene sulphonamide absorption and a 241 mμ band to the pyrimidine ring. Such comparisons with simpler analogous compounds make it possible to associate the bands with absorbing groups in the molecules.

Pulsation Theory of Cepheid Variables

P. L. Bhatnagar and D. S Kothari, Department of Physics, University of Delhi, in a paper "A Note on the Pulsation Theory of Cepheid Variables" (*Mon. Not. Roy. Astro. Soc*, **104**, 292, 1945), deal with certain points raised in Prof. Svein Rosseland's George Darwin Lecture (see *Nature*, **153**, 261; 1943). Rosseland developed his theory of 'anharmonic pulsations' and found that the semi-amplitude of oscillation would have to be a quarter of the star's radius—a value which is four or five times too great for most of the Cepheids. The authors of the present paper point out that this and other results obtained by Rosseland are not inherent in the model, but arise because of an approximation introduced in the investigation. They treat the matter in a simpler way than Rosseland, assuming γ, the ratio of the specific heats, to be 5/3, and avoiding the approximation introduced by Rosseland. The conclusion is that the theory of anharmonic oscillations for the above ratio cannot account for the observed skewness in the velocity – time curve of the Cepheid variables. The observed skewness demands a semi-amplitude almost equal to R, whereas the observed value is about $0{\cdot}1\ R$, unless the value of γ is assumed to be much greater than 5/3. A rough calculation shows that if the observed skewness is to arise for a semi-amplitude of $0{\cdot}1\ R$, γ is comparable to 10.

Van Biesbroeck's Star

IT is announced (*Harv. Obs. Card* 697) that W. J. Luyten and P. D. Jose have found the colour index of Van Biesbroeck's faint companion to BD+4°4048 to be 1·4 and the photographic magnitude 19·5 giving a photovisual magnitude of 18·1. The colour index was derived from blue and yellow plates taken with the 36-in. reflector of the Stewart Observatory It is surprisingly low for so faint a star (absolute magnitude 19·3 photovisually) and in addition there are several stars in the vicinity which are as red as, or even redder than, the proper motion star. This suggests the possibility that this star, which has the lowest known luminosity, is a degenerate star and approaches a black dwarf. It is remarked that it might be a star the surface temperature of which corresponds to that of an early M dwarf, but the luminosity of which is several thousand times lower

OXIDATION-REDUCTION ASPECTS OF RESAZURIN

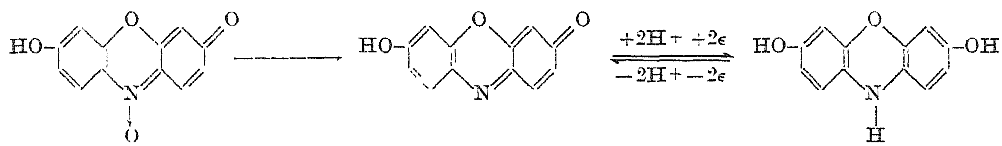
By the late R. S. TWIGG
London School of Hygiene and Tropical Medicine
and
National Institute for Research in Dairying

RESAZURIN was discovered by Weselsky[1], and first used by Pesch and Simmert in 1929[2] for estimating the bacterial content of milk. It has lately been extensively used in Great Britain as a basis for a number of tests for the hygienic quality of milk[3,4]. Reduction takes place in two stages

Resazurin	→	Resorufin	⇄	Dihydroresorufin
(blue)		(pink)		(colourless)

In fresh milk, reduction is chiefly due to cells (mastitis, etc.), and in aged (for example, 24 hours old) milk, to bacteria.

Work has been carried out electrometrically at 30° C in the absence of oxygen, on the two stages of reduction :



Resazurin Resorufin Dihydroresorufin

Only the second stage of the second reduction is reversible at an inert electrode.

Electrometric titration curves of resazurin at pH 6·55 compared with curves of the same amount of resorufin at the same pH show that during the first reduction some of the latter is simultaneously reduced to dihydroresorufin (Fig. 1). This is true, at least, between pH values of 6 and 7.

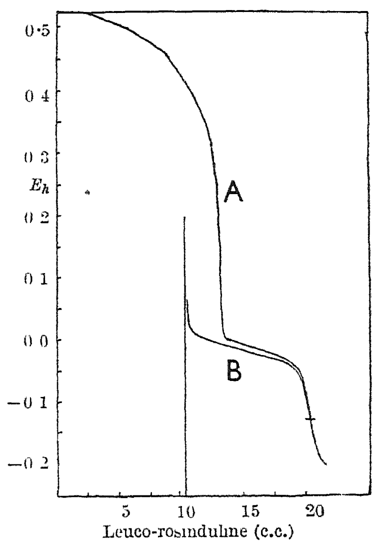


Fig 1 *A*, TITRATION OF 20 C.C. RESAZURIN.
B, ,, ,, ,, RESORUFIN.
All solutions 0 000132 *M*, pH 6·55.

The courses of the oxidation-reduction curves of the reaction resorufin ⇄ dihydroresorufin resemble those of nearly all other reversible dyestuffs in that two electrons per molecule are transferred in the reaction, at any rate at pH values greater than 3·0.

The $E'_0 - p$H curve, constructed from the table on p. 402, is shown in Fig 2 All points were taken from measurements made by the 'method of mixtures', but some, including those at pH 6 583, 6·867 and 7·431, have been confirmed by titration.

The curve shows four sections having $- dE_h/dpH$ values of 0·03, 0·06, 0·09 and 0 06 successively from high to low values of pH. This, together with the other chemical aspects, shows that the system conforms to W. M. Clark's formulation $Ox + 2e = \overline{Red}$[5].

The electrode equation which describes the above findings and agrees with the observed values in the table is

$$E_h = E_0 - 0\ 03006 \log \frac{[S_R]}{[S_O]} + 0\ 03006 \log \left[\frac{K_1K_2(H^+) + K_1(H^+)^2 + (H^+)}{K_0 + (H^+)}\right].$$

The calculated value of pK_0 is 6·93, and of E_0 is $+$ 0·380 v. By adopting for pK_1 and pK_2 the values 9·26 and 10·02 respectively, the calculated values are given in the table.

The calculated and observed values agree fairly well, except at pH values of 6 583, 6 867 and 7·431 (of which the first two fall within the normal range of the pH of milk). These three large deviations may be due to low solubility characteristics, but it was deemed unwise to decrease further the concentration of the dye (which is 0·000015 *M* in the experiments), owing to the ease of re-oxidation of dihydroresorufin by traces of oxygen.

From pH 3 up to the high acidities of hydrochloric

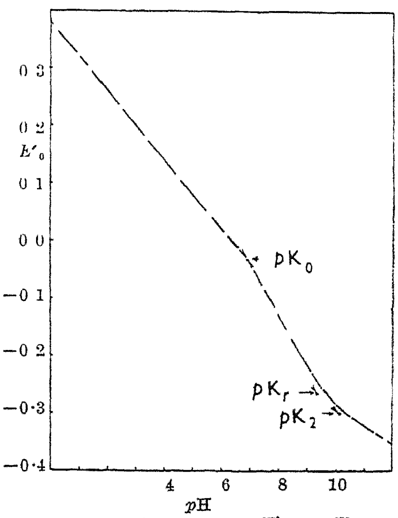


Fig. 2. RELATION OF E'_0 TO pH.

pH	Calculated	Observed	Deviation
0 188	+0 369 v	+0 369 v	0·000
1 005	0 320	0 322	−0 002
1 390	0 297	0 299	−0 002
2 454	0 232	0 231	+0 001
3 392	0 176	0 176	0 000
4 477	0 111	0 111	0·000
5 570	0 045	0 045	0·000
6 119	+0 010	+0 012	+0 002
6 583	−0 021	−0 016	+0 005
6 867	0 042	0 032	−0 010
7 431	0 085	0 081	−0 004
7 880	0 123	0 122	−0 001
8·338	0 163	0 163	0 000
9 186	0 231	0 231	0·000
9 547	0 256	0 256	0·000
10 053	0 284	0 285	+0 001
10 605	0 307	0 308	+0 001
11 454	0 335	0 336	+0·001
11 743	0 344	0 345	+0 001
12 228	−0 359	−0·360	+0 001

acid or sulphuric acid, a blue-green compound, presumably a meriquinone, is formed by the reduction of resorufin with titanous salts, or by oxidation of dihydroresorufin with quinone or potassium dichromate. While the reduction method shows that a meriquinone having an oxidant : reductant ratio of 1 : 1 occurs, the oxidation method, curiously, shows a 3 : 2 ratio.

If a solution of resazurin be acidified to 4 76 N with hydrochloric acid, and potassium iodide be added to a final concentration of 0·06 N, a spontaneous reduction of the resazurin proceeds not only to resorufin, but also to a further half reduction of the resorufin so formed to the meriquinone stage, with the release of the equivalent amount of iodine, which may be extracted with carbon tetrachloride and determined by an iodate titration. On the other hand, if the resazurin be acidified to 3 N with sulphuric acid or about 1·2 N with hydrochloric acid, and potassium iodide added to 0·06 N, only the complete reduction of resazurin, without further reduction of the resorufin so formed, occurs. This difference depends upon the low solubility of resorufin in the medium, and upon the observation that at these high acidities the potential of an iodine – potassium iodide mixture at an inert electrode decreases with increasing acidity, which is contrary to experience with other systems.

Commercial resazurin contains variable amounts of resorufin. These latter findings have led to the development of a method for estimating the amount of resazurin in a sample together with any resorufin present as an 'impurity'.

If A is the iodine equivalent of the first procedure, and B that of the second, then, if RZ = resazurin, RF = resorufin :

$$A = 2RZ + [RZ \text{ (as 'formed' } RF) + RF \text{ (as 'impurity')}]$$
$$= 3RZ + RF$$
$$B = 2RZ, \text{ or } RZ = \frac{B}{2}$$
$$\therefore A = \frac{3B + 2RF}{2},$$
$$\text{and } RF = \frac{2A - 3B}{2}.$$

These equations have been verified by electrometric investigations carried out in conjunction with iodine estimations.

I am indebted to the Agricultural Research Council for a grant in aid of this work.

[1] Weselsky, *Berichte*, **4**, 32, 613 (1871).
[2] Pesch, K. L , and Simmert, U , *Milchw. Forsch* , **8**, 551 (1929).
[3] Baker, W., *et al.*, *Biochem. J.*, **36**, 1/2, 1 (1942).
[4] Davis, J. G , *Food Manufacture*, **17**, 308, 344 (1942).
[5] Clark, W. M., *U.S. Pub. Health Rep.* (Reprint No 826)

INDUSTRY AND UNIVERSITY EDUCATION

THE proceedings of the Conference of Industrial Representatives on "Industry and University Education", convened by the Vacation Work Committee of the Imperial College of Science and Technology Union on December 15, have now been published. At the first session, on "Post-war Technical Requirements in Industry", Dr. P. Dunsheath, in a paper on "Industry's Requirements in Personality", suggested that university education tends to lay too much emphasis on the working of things and to give insufficient attention to human relationships and the working of the mind. University graduates are of much greater value to industry when, in addition to their equipment of mathematical and scientific data, they possess some knowledge of humanity with its intricate and sometimes contradictory relations. Urging that the universities should concern themselves with developing the characteristics making for leadership, Dr. Dunsheath emphasized the importance of a sense of proportion and the ability to get ideas understood by others. He believes that more attention should be given to the classification of students according to their real aptitude for research, for design, for production or for teaching : good brains are required in design and production as well as in research, and above all in teaching. All administrative posts in scientific industry should be filled, he thinks, by those with scientific and technical knowledge of the industry.

Mr. E. R. Davies, director of research, Messrs. Kodak, Ltd., pointing out that the problems of the industrial research worker always tend to lead him back to problems in pure or applied science which are not peculiar to his industry but of much wider interest, deprecated further specialization during the undergraduate years. More emphasis should be placed on postgraduate work, but the men required should be scientists first and technologists second. He thinks that technologists in the production and distribution sides would be drawn largely from the technical colleges. Although he would welcome the establishment of a university chair in photography, he would prefer to see postgraduate training continued in pure and applied science as it is at present. Its main aim should be to train a man in research methods, but he would like to see some broadening of the basis of scientific training at the graduate stage. There should be the closest possible contact between the universities and industry.

In the discussion, Lord Eustace Percy suggested that industry should find more men within its own ranks who are worthy of a university education and could profit by it. Dr. G. M. Dyson referred to the need for thoroughly re-organizing the technical colleges, adequately endowing and equipping them and providing them with sufficient men to cope with teaching and to prosecute research as well. Dr. J. A. C. Williams put in a plea for including the philosophy and psychology of engineering in the university engineering course, and for increased use of the technical colleges for refresher purposes.

The second session of the Conference, which considered "Post-war Requirements in Scientific Education", was opened by Prof. L. Bairstow, who pointed out that scientific education cannot be considered adequately as a separate subject apart from the rest of life, and referred to the economic difficulties

attending any extension of a student's career, especially for the majority whose work is less absorbing than research and where compensations are necessary. Specialization, or differentiation, should not come before the third year, and even then should not involve a student being committed to one field for the rest of his life. He believes that we need more training in administration for a limited number of people, who would in due course take their place with those who have studied life from a different aspect. Then we should retain, and possibly extend, a completely free atmosphere for those students who take naturally to research. We also need a better administrative attitude to research, and also technical high-schools and extended facilities in the ordinary technical schools.

Prof. H. V. A Briscoe confined himself to the question of producing men destined for teaching positions in pure and applied science and in the industries using applied science He stressed the importance in recruitment of selection and of widening the field of choice; we must look critically and constructively at this question of extended recruitment and make a scientific career attract more of the really good men who at present go into other fields. Then he stressed the importance of excellence in the teaching staff with reference to imparting selected principles and facts in science so as to inculcate and develop intellectual integrity and to display the cultural aspects of science, as well as to the provision of opportunities for special development. Curricula are overloaded, and we must remember that the task is education, not teaching. Lastly, there is the question of assessment and guidance in the valuation of the graduate, so that he does what is best in his own interest and in the interests of the community. Here full co-operation of the employer is essential. With regard to the desirability of having first-class men for production, he believes that the choice between research and production should be left open and that we should aim at turning out keen, properly equipped scientific workers, whose careers would be determined by their aptitudes and opportunities.

Dr. R. V. Southwell, stressing the importance of a real partnership with industry, suggested that we may find that the best arrangement is not one in which three years at a university are followed by two years in industry, but one in which the last of the five years sees a man returning to his university. A man who enters industry should not have finished with his university, and we might well keep a more open mind on the order in which the years are spent between industry and the university.

Mr J. W. Sawtell emphasized the importance of good management; he thinks that we should impress on the universities the need for men with a scientific education who can manage and handle other people, and appreciate the importance and dignity of management as a profession. Mr. L. P. Combes pointed out that regard must be had to the question of national service and its incidence on the age of recruitment. Mr. D. A. Bell thinks that one reason why graduates tend to enter industry only in research departments is that management has not been regarded as a worthy or scientific profession. In written subsequent contributions, Mr. W. S. Flight referred to the economic difficulties of a long period of training and a possible solution through the State bursary scheme, and Mr. M. I. Freeman urged that some training in the principles of industrial administration and organization should be given by the university rather than by industry.

Dr. A. J. F. Welch referred to the importance of vacation work and of having on academic staffs those with first-hand acquaintance with industrial conditions, while Dr. F. M. Potter, urging the value of a sound fundamental knowledge and elementary background of several subsidiary sciences, suggested that students would do well to avoid the tendency to live with men in the same year who are studying the same branch of science.

MODE OF ACTION OF PENICILLIN

IN an article on penicillin treatment in *Nature* (677, Nov. 25, 1944) reference was made to the work of Lieut.-Colonel J. W. Bigger (*Lancet*, 497, Oct. 14, 1944), who concluded that penicillin actually kills *Staphylococcus pyogenes* He suggested that it kills them at the time of division and has no effect upon individual cocci which are not dividing. These, therefore, persist in broth cultures, which penicillin frequently fails to sterilize, and are the explanation of that failure. Bigger proposed to give penicillin intermittently, in the hope that these 'persisters' would begin dividing in the intervals of the penicillin doses and so would be killed by the next dose. Bigger refers to the work of C. D. Gardner (*Nature*, **146**, 837; 1940), who found that, in weak concentrations of penicillin, cocci swelled to three times their normal size without division, and bacilli showed similar changes.

E. W. Todd (*Lancet*, 74, Jan. 20, 1945) also refers to this and other work in his report on his experiments on the bacteriolytic action of penicillin. Working with Pneumococcus Types I, II and III and with *Streptococcus viridans*, hæmolytic streptococci, staphylococci and *Clostridium welchii*, he found that all the strains of these organisms which he used were lysed by penicillin, but that such organisms as *Bact. coli* and *Pseudomonas pyocyanea*, which resist penicillin, were not lysed by it. But penicillin, he concluded, can kill organisms without lysis When lysis occurs, its rate depends on the actual or potential rate of multiplication of the organisms. Their multiplication, as G. L. Hobby, K. Meyer and E Chaffee (*Proc. Soc. Expt. Biol., N.Y.*, **50**, 281; 1942) also found, is essential for the action of penicillin. "It would appear that bacteriostasis, bactericidal action and bacteriolysis may be different stages of a single process proceeding in that order." The most rapid lysis occurs with organisms at the maximal rate of multiplication. This may be the real reason why penicillin is so effective, that is, because young actively multiplying cultures are more susceptible to bacteriolysis, so that organisms in the phase which enables them most readily to invade the human body are also then most susceptible to lysis.

These conclusions may be compared with those of Prof. L. P. Garrod (*Brit. Med. J.*, 108, Jan 27, 1945), who agrees that penicillin actually kills susceptible bacteria. He quotes the further opinion of L. A. Rautz and W. M. M. Kirby (*J. Immunol.*, **48**, 335; 1944) that penicillin is actually bactericidal. Garrod gives, however, only qualified support to Bigger's hypothesis that penicillin is bactericidal only to organisms when they are about to divide, which was, he says, also put forward by G. L. Hobby and M. H. Dawson (*Proc. Soc. Expt. Biol., N.Y.*, **56**, 178; 1944) and by C. P. Miller and A. Z. Foster (*ibid.*, **56**, 205).

Against this hypothesis, Garrod maintains, are (1) his experiments on the effects of temperature; like other disinfectants, penicillin is more active at higher temperatures, but is even more active at 42° C, when bacterial growth ceases, than at 37° C.; incidentally, Garrod finds that its action is impaired by increase of the acidity between pH 7·0 and 5·0, (2) the fact that bacteria from both old and very young cultures are almost uniformly susceptible. Garrod therefore thinks that there is no conclusive evidence in support of Bigger's proposal to give penicillin intermittently, and claims that clinical experience supports his view. Penicillin treatment fails because the organisms are inaccessible inside necrotic areas or in undetected abscesses.

Further important conclusions drawn by Garrod are that nothing is to be gained by using higher concentrations of penicillin (cf. Sir A Fleming, *Lancet*, 621, Nov 11, 1944; see also *Nature*, **155**, 341, March 17, 1945), especially in local treatment. The idea that higher doses will be more effective does not apply to penicillin. The reverse is truer. A concentration of 1 unit per c c. is not only just as effective as one of 1,000 units, but is often more effective. The only good reason for using stronger solutions in local treatment is to ensure that the concentration does not fall below the minimum fully effective level of about 0·1 unit per c.c. Garrod further emphasizes the importance of the purity of the penicillin which is being used experimentally. He found that all commercial penicillins tested were less active in higher than in low concentrations. Presumably impurities were responsible for this, and they cause serious obstacles to the study of the action of penicillin. It will be necessary to find out whether penicillin is a single substance of unvarying composition and uniform action.

Discussing these results in a valuable leading article, the *British Medical Journal* (123, Jan. 27, 1945) directs attention to the enormous variation in the susceptibility of various bacteria to penicillin. Some species classed as totally resistant are affected by higher concentrations of penicillin; for example, the typhoid bacillus and the salmonellas. H. F. Helmholz and C. Sung (*Amer. J. Dis. Children*, **68**, 236; 1944) have found that some resistant bacteria in the urine are affected by high concentrations, for example, *Proteus* and some strains of *B. coli*. Only *Bact. aerogenes* and *Pseudomonas pyocyanea* remained unaffected. The treatment of some infections of the urinary tract with penicillin might thus be effective. E. W. Todd, G. S. Turner and L. G. W. Drew (*Brit. Med. J.*, 111, Jan. 27, 1945) have found that *Staphylococcus* strain Oxford H. can be trained by growth in increasing quantities of penicillin to become 3,000 times more resistant to penicillin than it originally was. Similar results were obtained with another strain of *Staphylococcus*. Unlike other organisms which become 'drug-fast', however, *Staphylococcus* lost this property rapidly in media not containing penicillin. The authors refer to work which showed, on the other hand, that pneumococcus type III, made resistant to penicillin, either by culture in media containing penicillin (G. Rake *et al.*, *J. Immunol.*, **48**, 271; 1944) or by passage through mice treated with penicillin (L. H. Schmidt and C. L. Sesler, *Proc. Soc. Expt. Biol.*, *N.Y.*, **52**, 353; 1943), retained its resistance. The nature of these phenomena of resistance requires further investigation. Although some organisms can produce a penicillinase which destroys penicillin (see, for example, the penicillinase produced by *B subtilis* reported by E S Duthie, *Brit. J. Expt. Path.*, **25**, 96, 1944), resistance to penicillin apparently does not always depend on the production by the resistant organism of penicillinase. W. M. Kirby (*Science*, 452, June 2, 1944) has extracted a substance which is not penicillinase from *Staphylococcus* resistant to penicillin G. LAPAGE

INDIAN FOREST YIELD TABLES

EVER since the Forest Research Institute came into being at Dehra Dun (1907), the Sylvicultural Branch set out to obtain data for the preparation of volume and yield tables for some of the more important timbers such as teak, sal, and deodar, to mention but three of the best known throughout India. Selected sample plots of varying type and age had been previously formed by the forest officer in different parts of India, and more or less periodically measured and records kept. But for the most part the work was spasmodic and a proportion at least of the data obtained of doubtful usefulness.

As a result of the work inaugurated, attempts were made to prepare yield tables, among others, for the sal (*Shorea robusta*); such a table was prepared by Smythies and Howard and published in 1923. It was based on the measurements of some fifty-two plots of sal, chiefly in the United Provinces, with a few in Bengal and the Central Provinces. The sal has a wide distribution from the foothills and neighbouring border in the plains in the United Provinces as far west as the Jumna River, eastwards along this line through Nepal and Bengal Duars into Assam as far as Tezpur, its eastern boundary. To the south it is found in the eastern part of the Central Provinces and in Chota Nagpur, south-western Bengal, Orissa Province and Orissa Feudatory States to Ganjam in the Madras Provinces. It thus is equally at home in a dry hot as well as in a damp hot climate, and grows on a variety of soil conditions. Since the above tables were published, many more data have been collected, and this information has been collated in *Indian Forest Records* (Sylviculture New Series, "Yield and Stand Tables for Sal (*Shorea robusta*) High Forest" (4.A., No. 4, Model Press, Delhi, 1943) by M. L. Griffith, sylviculturist, and Bakhshi Sant Ram. The present tables are based on 542 measurements from 225 sample plots in twenty-five forest divisions of five provinces. Sample plot selection, upkeep and measurements in the different provinces are now greatly facilitated by the existence in the provinces of provincial sylvicultural research officers whose investigations and results are available to the Central Research Institute. That this departure is of the highest value is evidenced by the authors' remark, "The tables now produced are admittedly not completely satisfactory on account of the abnormality of some of the basic data. The main difficulties arose through inconsistent thinning procedure. These have been described in more detail together with the methods attempted to overcome them."

Just as the progress in ordered management of a forest department is indicated by the number of the forests which have been placed under working plans, including the type of plan in force, so the degree to which sylvicultural work has advanced is evidenced by the possibility of being able to prepare suitable yield and stand tables for use in the forests under management.

ADSORPTION OF WATER BY PROTEINS

IT is recognized that proteins contain two types of hydrophilic groups capable of binding water by hydrogen-bond formation, namely, polar side-chains such as those from lysine, glutamic acid, tyrosine, etc., and the oxygen and nitrogen associated with peptide bonds in the peptide chains. Adsorption curves are of the typical *S*-shape separable into three segments, the first part, at low pressures, characteristic of Langmuir adsorption, a second part with a more or less linear relation between adsorbed amount and vapour pressure, and a third part corresponding with a large increase of amount adsorbed with increase of vapour pressure.

H. B. Bull (*J. Amer. Chem. Soc.*, **66**, 1499; 1944), who defines protein hydration as water released when moist protein in equilibrium with saturated water vapour at 25° or 40° is dried in vacuum for 24 hours at 105°, and calculates the free energy and heat changes in adsorption, concludes that the theory of multi-layer adsorption proposed by Brunauer, Emmett and Teller (*J. Amer. Chem. Soc.*, **60**, 309; 1938) explains the results in a very satisfactory manner. This extends the Langmuir theory of monolayer gaseous adsorption to the case where more than one layer of molecules are adsorbed, and the resulting curves were found to resemble those obtained in the experiments.

The results are believed to be consistent with the view that the protein molecules in the solid state are linked together to form coherent planes, the exposed surfaces of which are hydrophilic, and water is adsorbed between these planes. The final rise is thought to correspond with a saturation of exposed polar groups with water and the beginning of a process of solution of the protein. Heat coagulation of egg albumin seems to involve interaction between polar groups on neighbouring molecules, with a decrease in water-binding capacity.

It is thought that there is no direct relation between the amount of water held by a solid protein in a saturated atmosphere and the amount of water held by a protein when it is dissolved in water, the latter being mainly dependent on the total hydrophilic surface exposed to the water.

EFFECT OF MULCHING ON THE SOIL

MULCHING is a recognized method of conserving soil moisture, but often several other effects of the treatment are noticeable. This is not, of course, unexpected when the mulch consists of organic material containing soluble plant nutrients in greater or less amount.

I. W. Wander and J. H. Gourley[1] found that mulching with straw increased the contents of potassium, calcium, magnesium, phosphorus and iron in the soil, the effect being most marked for potassium, while H. Painter and G. F. Potter[2] report that with young tung trees mulching reduced signs of potassium deficiency; and C. E. Baker[3] found a mulch as effective as dressings of muriate of potash in increasing the potassium content of apple and peach leaves. These results may not be due entirely to potassium supplied by the mulch, as C. E. Baker[4] found that mulching with cinders or glass wool increased the potassium content of apple leaves, possibly because under the mulch a concentration of feeding roots near the soil surface, where potassium concentration is highest, occurred. Mulching with poor hay, also with apples, encouraged the production of surface feeding roots in addition to increasing soil moisture[5].

The effects of mulching, however, are not always beneficial, and L. P. Latimer and A. P. Percival[6] found that although hay or seaweed mulches, as compared with grass covering, increased growth and fruit sizes in apples, sawdust used as a mulch did not have this effect, but did increase fruit and decrease leaf colour, suggesting that it had induced a slight nitrogen deficiency. W. A. Johnson[7], using sawdust as a surface mulch for tomatoes, found that it decreased the soil nitrate content slightly and when incorporated in the soil, as mulch materials usually are eventually, depressed the soil nitrate appreciably so that heavier nitrate applications were required. The sawdust conserved soil moisture and caused the soil to be less compact, but repeated sawdust mulches may have undesirable effects. L. M. Turk and N. L. Partridge[8] found peat unsatisfactory as a mulch as it prevented light rain from reaching the soil, while loss by evaporation from the mulch continued. These ill-effects were not found when the mulch used allowed free percolation of water, and gravel, straw and sawdust were all effective in this respect.

[1] *Proc. Amer. Soc. Hort. Sci.*, **42**, 1 (1943).
[2] *Proc. Amer. Soc. Hort. Sci.*, **42**, 17 (1943)
[3] *Proc. Amer. Soc. Hort. Sci.*, **39**, 33 (1941).
[4] *Proc. Amer. Soc. Hort. Sci.*, **43**, 7 (1943).
[5] *Proc. Amer. Soc. Hort. Sci.*, **42**, 30 (1943).
[6] *Proc. Amer. Soc. Hort. Sci.*, **44**, 52 (1944).
[7] *Proc. Amer. Soc. Hort. Sci.*, **44**, 407 (1944).
[8] *Proc. Amer. Soc. Hort. Sci.*, **38**, 59 (1941).

FORTHCOMING EVENTS

Wednesday, April 4

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. J. Macdonald: "The Freezing Point of Sour Milk"; Dr. H. Liebmann and Mr. A. D. Ayres: "The Electrometric Determination of Ascorbic Acid"; Mr. H. W. Webb: "Magnetic Stirring in the Electro-Deposition of Metals".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (joint meeting with the TELEVISION SOCIETY) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. C. Birkinshaw and Mr. D. R. Campbell: "Studio Technique in Television".

Thursday, April 5

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. J. C. Connell, Mr. O. W. Humphreys and Mr. J. L. Rycroft: "The Place of Radiant, Dielectric and Eddy Current Heating in the Process Heating Field".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Dr. A. G. Pugsley: "Modern Experimental Work on Aeroplane Structures".

Friday, April 6

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Are Engineers Losing their Sense of Proportion on the Accuracy of Industrial Measurements?" (to be opened by Mr. H. D. Hawkes).

INSTITUTE OF PHYSICS (SCOTTISH BRANCH) (in the Natural Philosophy Department, The University, Glasgow), at 7.30 p.m.—Dr. W. Hume-Rothery, F.R.S.: "The Theoretical Interpretation of Alloy Structures".

Thursday, April 5—Monday, April 9

BRITISH PSYCHOLOGICAL SOCIETY (at the University College of the South-West, Exeter)

Friday, April 6

At 9 30 a m —W. D Furneaux "An Experimental Study of Suggestibility and Hypnosis", Winifred Raphael "Surveys of Employee Attitude" At 11 20 a m —Hilda Lewinsky "Psychological Aspects of Cooking for Oneself", W. D. Wall · 'Reading Backwardness in the Army". At 5 p m —Margaret Lowenfeld "The Mosaic Test"

Saturday, April 7

At 9 30 a m —Discussion on "Psychological Implications of Culture Patterns" (Prof T H Pear, Dr A I Richards and other speakers) At 5 p m.—Dr. Millais Culpin Presidential Address At 8.30 p m — Display of Instructional Films arranged by the Visual Education Centre University College, Exeter.

Sunday, April 8

At 2 30 p m —An Account of the Work of the Devon Committee for Education in Mental Health and of the Committee of Professional Psychologists (Mental Health) of the British Psychological Society At 5 p m —M. D Vernon · "Perception and Understanding of Graphical Material", Charles Burns "Types of Problem Children" At 8.30 p.m.—Alec Rodger 'The Work of the Admiralty Psychologists", G Patrick Meredith "The Problems and Methods of Visual Education".

Monday, April 9

At 9.30 a m —Eric Farmer Problems in the Occupational Adjustment of the Blind: M I Dunsdon "The Binet Test as adapted for the Blind" At 11 20 a m.—I Langan "Demonstration of Binet Tests for Blind Children" At 11.50 a m.—M. B Stott · "Some Differences between Boys and Girls in Vocational Guidance". At 5 p m —Dr. K. J. W. Craik. "Refractory Period in Sensory-motor Action"; H. Himmelweit · "Level of Aspiration, as related to Neurosis and Temperament". At 8 30 p.m —Open Session for Discussion.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER to the Borough of Barking—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No D.1048 XA) (April 9).

GRADUATE TEACHER OF MECHANICAL OR ELECTRICAL ENGINEERING in the Southend Municipal College—The Chief Education Officer Education Office, Warrior Square, Southend-on-Sea (April 10).

PATENT AGENT, preferably specializing in ELECTRONICS, as Assistant in Patent Department—The Ministry of Labour and National Service, Appointments Department, Central (T and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3427.XA) (April 11)

MECHANICAL ENGINEER (fully qualified), in N.W. Area, by Engineering Company designing and constructing Electricity Generating Stations and Industrial Plants—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No. C.2512 XA) (April 12).

GRADUATE ASSISTANT LECTURER in the MECHANICAL ENGINEERING DEPARTMENT in the Coventry Technical College—The Director of Education, Council House, Coventry (April 16).

ASSISTANT LECTURER AND DEMONSTRATOR IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 21)

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY—The Secretary and Registrar, The University, Bristol (April 23)

ORGANIC CHEMIST IN THE RESEARCH DEPARTMENT of a well-known firm in the London area, to carry out experimental work leading to the formulation of protective and decorative coatings for sheet-metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W C.2 (quoting Reference No. F 2719.XA) (April 26).

MECHANICAL AND ELECTRICAL ENGINEERS by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2526 A) (April 28).

CHAIR OF PHILOSOPHY in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 28).

CHIEF ANALYTICAL CHEMIST IN THE RESEARCH DEPARTMENT of a well-known firm in the London area—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No F 3673.XA) (April 28).

ASSISTANT SECRETARY TO THE INSTITUTE OF PHYSICS—The Secretary, Institute of Physics, c/o The University, Reading, Berks. (April 28).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Sheffield (April 30).

METALLURGIST for a position in the RESEARCH DEPARTMENT for a large firm in Yorkshire—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2721.XA) (April 30)

KEEPER OF THE DEPARTMENT OF ZOOLOGY—The Director, Museum and Art Gallery, New Walk, Leicester (April 30).

METALLURGIST for a position in the RESEARCH DEPARTMENT of large firm in South Wales—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 2720 XA) (May 12)

PROFESSORSHIP OF MECHANICAL ENGINEERING—The Principal, Heriot-Watt College, Edinburgh (May 14)

UNIVERSITY CHAIR OF CHEMISTRY tenable at King's College—The Registrar, University of London, c/o Richmond College, Richmond, Surrey (May 18)

READERSHIP IN HUMAN PHYSIOLOGY—The Registrar, University Registry, Oxford (June 16)

KEEPER OF THE DEPARTMENT OF ART—The Director, National Museum of Wales, Cardiff (June 30)

GEOLOGIST to the Government of Trinidad to co-ordinate geological information, compile geological map after necessary surveys and advise on geological questions connected with petroleum industry development in the Colony—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. F 3769.A) (August 31)

MECHANICAL INSPECTOR OF WORKS (temporary) by the Government of Sierra Leone for the Electricity Branch of the Public Works Department—The Ministry of Labour and National Service, Appointments Department, A 3(A), Sardinia Street Kingsway, London, W.C 2 (quoting Reference No O S 605)

EDITORIAL ASSISTANT by British Council to help in production of a monthly journal published in several languages—The Ministry of Labour and National Service, Appointments Department, A.3(A), Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. P Q. 144)

DIRECTOR OF THE CITY OF LONDON COLLEGE—The Secretary, City of London College, Electra House, Moorgate, London, E C.2

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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